

2nd European Immersive Education Summit

Paris, 26-27 November 2012

École Nationale Supérieure des Arts Décoratifs
(Paris, France)

Editors:

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Preface from the editors

This is the proceeding of the 2nd European Immersive Education Summit. It was hold at the École nationale supérieure des Arts Décoratifs (Paris, France) on 26 and 27 November 2012. This is the second Summit organized by the European Chapter of the Immersive Education Initiative and follows the tradition of many other Summits mainly organized in Boston, MA, USA. These summits bring together academia and industry to provide the latest innovations around 3D virtual worlds for education.

The theme for the 2nd European Immersive Education (iED) Summit was:

Immersive Education: combining creativity, art and pedagogy

The 2nd European iED summit built on this theme, exploring how virtual spaces could be used for innovative forms of teaching and learning, fostering creativity and artistic expression. This was rooted in new technological developments in the fields of virtual, augmented and mixed reality. There was also a strong emphasis on pedagogy and effective design and evaluation of solutions, with case studies from active practitioners in this emerging cross-disciplinary domain.

To put together this programme an international Programme Committee was created with many experts from all around the world. Following the Call for Papers thirty submissions were received, which were reviewed by three reviewers on quality and appropriateness. The seventeen best papers were accepted either as full or as short papers for presentation at the summit and inclusion in the proceedings. For handling the organization of submitted papers, the handy Easychair system was used. Apart from the paper presentations, the programme also includes poster presentations and practical demos showing tools in action. Four keynotes represent a highlight in the program covering issues from the psychology of immersive environments to new pedagogies and technologies enabled by virtual worlds, and the use of virtual worlds to support creativity in the arts. Finally, a panel session with representatives from academia and industry was devoted to reflect about the future of immersive education technologies. All these activities comprise altogether a varied and thought-provoking programme.

As editors of these proceedings and main organizers of the Summit, we would like to thank the international Programme Committee members for doing an excellent job reviewing the papers, the local Organizing Committee for handling all the organizational issues that make a difference in the end, the École nationale supérieure des Arts Décoratifs for providing the basic infrastructure, and last but by no means least the Immersive Education Initiative and in particular its European Chapter for providing the support and encouragement to organize this event.

Paris, November 2012

Michael Gardner, Francois Garnier and Carlos Delgado Kloos (Editors)

Keynotes

iED Europe Summit 2012 KEYNOTE: Prof. Chris Fowler, University of the West Indies

"Virtual Reality and Learning: Where's the pedagogy?"



Prof. Chris Fowler, amongst other things, is responsible for the development and implementation of the Blended Learning Policy at the University of the West Indies. His first degree and doctorate are in Psychology. Before joining UWI in Oct 2010, he was Professor and Coordinator for Research & Evaluation at the Institute of Distance Education, University of Swaziland.

Between 2002 and 2009 he was the Professor and Director of Chimera, the Institute of Social and Technical Research at the University of Essex. Before that he worked for British Telecom's (BT) Research Department, leading their Education and Training Research Team, Asian Research Centre in Malaysia and their Customer Behaviour Laboratory in Ipswich, UK.

His current research interests include developing conceptual frameworks to support the design and evaluation of learning systems, learning and assessment in Virtual Worlds, and assessing the impact of Educational Technologies on the teaching and learning experience.

The presentation explores the use of semi-immersive, 3-D, Virtual Worlds (VW) for teaching and learning. It will begin by identifying the learning affordances and benefits offered by VW as a basis for providing a more pedagogical description

using the concept of pedagogical immersion as derived from Mayes' (1995) learning framework. It will draw upon examples of using VW for teaching science in the Caribbean, and explore innovative ways to assess learning within a VW. The paper adopts a 'design for learning' perspective and in doing so hopes the provided framework will prove useful to practitioners designing learning activities in VWs.

iED Europe Summit 2012 KEYNOTE: Prof. Alain Berthoz, Chair of Physiology of Perception and Action at the Collège de France

"The concept of *immersion* in the relation between brain, body of self and others, real and virtual spaces"



Alain Berthoz was born in 1939. He became Civil Engineer at École des Mines in 1963 getting his Ph.D. in 1973. Researcher at Centre National de la Recherche Scientifique (CNRS) (1966-1981), he established and coordinated the Neurosensory Physiology Laboratory of CNRS (1981-1993). Since 1993, he is honorary professor at the CNRS-Collège de France and director of the Chair of Perception and Action Physiology. Research fields covered by Alain Berthoz are the physiology of sensorimotor functions, oculomotricity, the vestibular system, control of balance and the perception of movement, spatial memory and neurorobotics in humanoids.

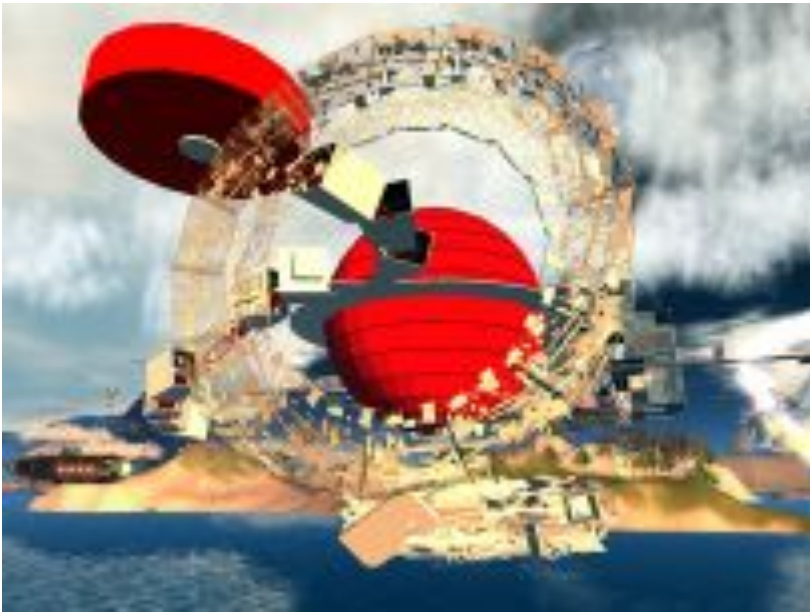
He is Chevalier de la Legion d'Honneur and Officer of the Order of Merit of the French Republic Commander of the Order of Merit of the Italian Republic. He is also member of the French Academy of Sciences; the French Academy of Technologies and the American Academy of Arts and Sciences. His many authored and co-authored books include *Les Sens Du Mouvement (The brain's sense of movement)* (Editions Odile Jacob, Paris, 1997, Ed. Harvard Univ. Press) and *Phénoménologie et physiologie de l'action (Phenomenology and Physiology of Action)* (Ed. Odile Jacob, 2006, Ed. Oxford Univ. Press, 2008).

This talk will deal with the concept of immersion and the relation between brain, body of self and others, virtual and real spaces. He will present a spatial theory of empathy and sympathy which may be useful for the design of social and emotional interactions between human agents and virtual world avatars. In the Neurosensory Physiology laboratory, he has conducted many experiments on the relationships between brain, body and space. The results showed that these actions are fundamental to the relationships: on one hand, the action of build a coherent body in its own space and secondly, the action of mentally manipulate spaces and reference spaces (in particular mechanisms of modification of point

of view). Prof. Berthoz explains that "perceiving space is perceiving movement in space".

Space perception is rooted in action: he calls it *perçaption*. In his keynote speech, he will present the various relationships between brain, body, real and virtual spaces and will focus on the question of immersion. The main issue will be to consider how human evolves in space and spatial reference. Therefore, how the body is immersed in real and virtual spaces? Are immersive mechanisms the same for real spaces and virtual environments?

iED Europe Summit 2012 KEYNOTE: Tribute to Chris Marker by Max Moswitzer



During this tribute, Max Moswitzer will show *L'Ouvroir*, a virtual museum where Chris Marker exhibits a series of photographs, film clips, video installations and other do-it-yourself multimedia.

L'Ouvroir was created in 2008 by Chris Marker (aka Sergei Murasaki or Guillaume-en-Egypte, his cat avatar, in SL) and Max Moswitzer (aka MosMax Hax) for the exhibition *Chris Marker: A Farewell to Movies* at the Museum of Design in Zurich.

Chris Marker (1921-2012), was a French photographer, documentary film director, film essayist, writer and multimedia artist. He was a photographer before moving to film direction in 1945. In 1953, he collaborated on the film *Les Statues meurent aussi* with Alain Resnais. He wrote and directed thirty films including *Lettre de Sibérie* (1957), *La Jetée* (1962), *Le Joli Mai* (1963), *Sans Soleil* (1983) and *Level Five* (1997). Chris Marker's films are at the cross-roads of documentary, ethnography and avant-garde cinema. In 2007, Chris Marker begun to explore Second Life's virtual platform and created in 2008, for his exhibition *Chris Marker: A Farewell to Movies* at the Museum of Design in Zurich, a virtual museum *L'Ouvroir* where he exposed a series of exhibits of photography, film clips, video installations and other do-it-yourself multimedia.

Max Moswitzer's Biography



Born in 1968, Max Moswitzer lives and works in Vienna and Zurich. He studied Graphic Arts at the University of Applied Arts in Vienna, in Ernst Caramelle's and Oswald Oberhuber's classes, and Communication Theory with Roy Ascott. Moswitzer's outputs are in Fine Arts and the construction of playful situations, for which he has used *dérive* and *détournement* as a methodology for the transformation and reverse engineering of networked computer games and art systems.

Starting from early 2007 Moswitzer has moved his creative practice into the metaverse, (ie. Second Life), and Opensimulator; where he is the founder of the Synthetic Academy, a university for avatars. His architectural installation *Whitenoise* has been one of the four winners on the first Annual Architecture & Design Competition in Second Life, an internationally juried event of the 2007 Ars Electronica Festival. His artistic output related to Second Life is also covered in the book *Space Between People: How the Virtual Changes Physical Architecture*, by Stephan Doesinger, published in 2008. More recently he has completed *L'Ouvroir* with Chris Marker, a virtual museum in Second Life commissioned by the Museum für Gestaltung, Zürich. He collaborated with Roy Ascott on *La Plissure du Texte 2* (LPDT 2), shown at the festival INDAF 2010 and at ISEA 2011. In early 2011 Max Moswitzer (a.k.a Mosmax Hax) created The New Genres Grid, which is a standalone virtual world dedicated to artistic and learning activity.

iED Europe Summit 2012 KEYNOTE: Mr. Janis Karklins, UNESCO

"ICT Competency Framework for teachers and Open Education Resources"



Before assuming duties as the Assistant Director General of Communication and Information of UNESCO, Ambassador Karklinš served as the Latvian Ambassador to France, Andorra, Monaco and UNESCO. He was as well the Permanent Representative of Latvia to the United Nations in Geneva. During his stay in Geneva, he served as the First Vice-Chairman, and one year later as Chairman of the Council of the International Organization for Migration (IOM). He has held several elected posts in the World Intellectual Property Organization (WIPO) and UN Commission of Science and Technology for Development, as well as presided over the Group of Governmental Experts on Cluster Munitions within the framework of the Convention on Certain Conventional Weapons (CCW). He also served as the Vice-President of the Preparatory Committee of the Geneva Phase of the World Summit on the Information Society (WSIS) and was President of the Preparatory Committee of the Tunis Phase of WSIS. Ambassador Karklinš represented Latvia in the Governmental Advisory Committee of ICANN and Chaired this Committee from 2007 until June 2010. Prior to the posting in Geneva, he served as the Under-secretary of State in Latvia. He also served as Counsellor in the Latvian Embassies in both France and Finland. He has an engineering degree from the Riga Technical University in Latvia and attended an Executive Education Program for Eastern European diplomats at the Hoover Institute at Stanford University in the USA.

UNESCO is the United Nations agency with a mandate to defend freedom of expression and press freedom. Article 1 of its Constitution requires the Organization to “further universal respect for justice, for the rule of law and for the human rights and fundamental freedoms which are affirmed to all the people in the world, without distinction of race, sex, language or religion, by the Charter of the United Nations.” To realize this the Organization is requested to “collaborate in the work of advancing the mutual knowledge and understanding of peoples, through all means of mass communication and to that end recommend such

international agreements as may be necessary to promote the free flow of ideas by word and image...”.

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Growing the Use of Virtual Worlds in Education: an OpenSim Perspective

Colin Allison¹, Anne Campbell, C.J. Davies, Lisa Dow, Sarah Kennedy, John McCaffery, Alan Miller, Iain Oliver, Indika Perera

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Abstract. The growth in the range of disciplines that Virtual Worlds support for educational purposes is evidenced by recent applications in the fields of cultural heritage, humanitarian aid, space exploration, virtual laboratories in the physical sciences, archaeology, computer science and coastal geography. This growth is due in part to the flexibility of OpenSim, the open source virtual world platform which by adopting Second Life protocols and norms has created a de facto standard for open virtual worlds that is supported by a growing number of third party open source viewers. Yet while this diversity of use-cases is impressive and Virtual Worlds for open learning are highly popular with lecturers and learners alike immersive education remains an essentially niche activity. This paper identifies functional challenges in terms of Management, Network Infrastructure, the Immersive 3D Web and Programmability that must be addressed to enable the wider adoption of Open Virtual Worlds as a routine learning technology platform. We refer to specific use-cases based on OpenSim and abstract generic requirements which should be met to enable the growth in use of Open Virtual Worlds as a mainstream educational facility. A case study of a deployment to support a formal education curriculum and associated informal learning is used to illustrate key points.

Keywords. Virtual Worlds, Education, Open Simulator, XMRRM, MUVE

Introduction

Immersive 3D Multi User Virtual Environments, hereafter referred to simply as Virtual Worlds, are currently used in a number of different sectors including training, games, entertainment, social networking and education. They have been of research interest to educationalists for over ten years since the availability of Second Life as a service on the global Internet. Virtual Worlds for learning have been created to support topics including Internet routing [1], WiFi experimentation [2], electromagnetic theory [3], programming algorithms [4, 5], HCI [6], archaeology [7], space science [8], cultural heritage [9], humanitarian aid [10] and linguistic and cultural competence for American forces [11]. Part of the motivation for using Virtual Worlds is that students and pupils readily engage with them, often more so than with conventional learning materials and contexts [5, 12]. Second Life was pioneering in its global reach but it was not designed for education and several commentators have highlighted problem areas that arise when using it for that purpose [13, 14]. These include: commercial cost, code size restrictions, age restrictions, unwanted adult

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content and other distractions, difficulty of coursework marking due to the permissions system, quality of experience due to remote servers, firewall blocking by campus computing services, a lack of facilities for copying and sharing content and backing up work outside of the virtual world. Other issues arise – those of ethics, trust, privacy – and the technological barriers to running a class with software which does not scale. In recent years OpenSim [15] has increasingly displaced Second Life (SL) as the platform of choice for developing immersive learning environments. OpenSim is an open source project which uses the same protocol as Second Life so is compatible with any SL compatible viewer/client including the SL viewer itself, Hippo [16], Meerkat [17] and Phoenix [18]. This software compatibility has resulted in a de facto standard for Virtual Worlds and has meant that OpenSim offers a natural progression from Second Life for educationalists. While OpenSim offers solutions to many of the significant drawbacks encountered with Second Life - commercial cost, age restrictions, land constraints, content sharing and backup - there are features (or the lack thereof) inherited from Second Life which act as barriers to a wider adoption of Virtual Worlds in education. This non-exhaustive set of challenges includes Management Guidance, Network Infrastructure, the 3D Web and Programmability. These are followed by a case study which involved deploying an immersive historical reconstruction as part of a national curriculum for high schools.

1. Management Guidance for Educators

Virtual Worlds bring a novel set of management challenges to the stakeholders at every level of MUVE use: educators creating a new learning environment, instructors using a ready-made learning environment, and learners. Due to the intrinsic characteristic of 3D simulations that Virtual Worlds are capable of defining unique use cases for different application domains based on their core set of system and environmental functions. As a result, managing Virtual Worlds can become a significant challenge, not only because they are new when compared to Web-based platforms, but also because they have a radically different nature which varies across application domains and underlying goals of the use. To support users for their MUVE management needs, we are researching suitable mechanisms with a particular focus on educational applications.

Virtual Worlds follow system and environment controls through Role Based Access Control (RBAC) [19]. OpenSim has three different categories and implementations of RBAC to cover the Virtual World functions, i.e., Land related RBAC, Content related RBAC, and Group related RBAC. These three different RBAC implementations are not mutually exclusive from one another; in fact, varying levels of interdependencies can be seen with prominence often given to the Land related RBAC. Further, when combined with the possible avatar activities and user management functions, all these create a complex and challenging scenario to manage Virtual World at the system level, let alone the complexity added by different Virtual World application domain requirements. However, interestingly, OpenSim does not enforce a specialised RBAC at server administration, but relies on the hosting server's operating system user access management. Therefore, any user with access to the server (directly or remotely) can perform administrator functions without any restriction; this can be a challenge for mainstream uses that require higher trust and security enforcement.

Briefly, Land or the spatial management of Virtual Worlds are based on three different levels with related roles: Estate (Estate Owner), Region (Region Owner), and Parcel (Parcel Owner). An estate can have one or more regions, and a region can have one or more parcels; similarly, an Estate Owner has the highest user privilege for that estate, and then the region and parcel owners have decreasing levels of control corresponding to their land ownership. The land privileges can affect the group and content management since the Virtual Worlds are designed with a focus on the 3D environment. Content management involves 6 different roles: Creator, Owner, Next Owner, Group, Everyone and Administrator (God), with functions, Move, Copy, Modify, Transfer and Delete. Combinations between these roles and functions can make Virtual World content management a difficult task. Moreover, complex scenarios such as composite permission, cyclic permission loss and fair ownership model were identified as essential factors for effective Virtual World content management [20]. Group management is relatively straightforward at the basic level with two roles, Group Owner and Member. However, the flexibility to define new roles for a given group and delegate owner privileges can create unexpected group management problems if not properly handled. Avatar activities are the main form of interaction with the 3D environment that users can practice. Indeed, these functions such as fly, teleport, gesture, terrain editing, content creation, etc. are the reasons why Virtual Worlds become so engaging and intuitive when compared to the 2D Web; therefore, restrictions on these functions for managing the Virtual World can result in a negative impact on their usability and attractiveness.

Considering the generic nature of these Virtual World functions and their core role in determining the success of the management of Virtual World usage in different educational domains, we have proposed a mechanism based on policy considerations. The advantage of this approach is it takes into the account the need for flexibility at the use case level to customise policy considerations. Therefore, it allows the users to practice unique policy considerations based on a selected Virtual World function, depending on their requirements at the application level.

We have defined a process for policy based management practice relating with the Kolb's experiential learning model [21], which has been widely considered to be successful with Virtual World supported teaching and learner support [22, 23]. As part of this management process development, an extensive user study with two student cohorts from undergraduate and postgraduate (taught) programs was performed to identify key policy aspects of Virtual World management. The study revealed that the policies should be based on promoting student self-regulatory behaviour and Virtual World system function management [24]. In view of this outcome, a policy taxonomy was introduced to avoid ambiguities at the policy making stage since there can be multiple ways of using Virtual Worlds for different educational needs. A further study with a sample of PhD students from Scottish universities stressed the fact that there should be user guidance and training for managing Virtual Worlds, especially on the functions and their complex interrelationships. This initiated our work on exploring different methods to train academics and students for their Virtual World interaction and management activities; an overview on the training environment which was developed follows.

1.1. User Training for Virtual World Management

To facilitate the need of user training for managing OpenSim we developed Training Island, with training centres to cover major policy areas related to Virtual World functions. A campus like architecture was used to make the academics feel at home. This region was accompanied by Introduction Island, for generic student training for rapid familiarisation with the Virtual World, implementing the SL concept of Help Island for new users, but in a more comprehensive manner focusing on educational uses. Training content and support materials were expressed in natural language with suitable figures to depict the Virtual World management task scenarios and related User Interface functions. Since the management and interactive tasks are done through user actions at the application level, it was decided to express the content in natural language; moreover, it adds flexibility and ease of training. Fig. 1 shows an aerial view of Training Island.



Figure 1. Training Island for academics: training for Virtual World management

In addition to the policy specific training centres, four generic virtual spaces and constructs were provided to increase user engagement and facilitate different types of training activities and media formats. These places are: the Discussion Rooms, the Cinema, the Open Forum and the Sandbox. The Cinema provides the virtual space to train users through a set of video content on managing learning activities in virtual worlds, the Open Forum is a dedicated place to summarise most of the Virtual World interacting functions with possible hot key combinations available in the viewer programs; this enables a rapid familiarity of, and efficient interactivities with the environment. The Discussion Rooms are places where group discussions can be hosted for training sessions on using Virtual Worlds. Finally, the dedicated Sandbox lets the users practice their learnt environment engaging and management functions without restriction; it helps to make the main training environment to be kept tidy and enforced with some restrictions on terrain alteration and object creation.

2. Networking Infrastructure Considerations

OpenSim's networking protocols and their parameter constraints are largely inherited from Second Life. These were originally developed over ten years ago, and although well studied [25, 26], have not been seriously revised despite advances in network infrastructure and computer capabilities over the past decade [27]. There are two general problem areas: security-motivated port blocking and use of bandwidth on the Internet.

In the first case a recurring problem encountered in the common educational settings of the School or the Campus is that the authorities who control institutional firewalls are reluctant to open the large range of ports (53, 3478, 3479, 5060, 5062, and 12000-29999) required for client-server communication, due to security concerns. This can be overcome by placing a server inside the institutional firewall but this is a poor solution in two respects: i) it removes the efficiency of running a particular learning environment as a single service from one or more servers across the Internet; and ii) there is no opportunity to mix and meet with users outside of normal institutional cyberspace boundaries – friends, fellow travellers and domain experts for example. Another solution is to lease an ISP connection, as ISPs deliver unfiltered IP, but in addition to the extra expense involved this approach may contravene institutional rules. In the second case it is necessary to understand that the Internet's good health is due in large part to TCP's self-regulatory congestion control algorithms [27], which also provide a type of fairness [28] in bandwidth usage amongst competing streams of traffic. So, for non-TCP based traffic, OpenSim for example, it is important that these applications dynamically manage their traffic transmission rates to be TCP Fair. In a nutshell, TCP takes loss as an indication of congestion and reduces its transmission rate. In the absence of loss it increases its transmission rate to take advantage of available bandwidth.

OpenSim implements its own adaptive traffic management mechanism, which involves a "throttle" mechanism to limit the maximum rate. This has three shortcomings: i) it fails to reduce its transmission rate in line with the TCP Fair algorithm in the presence of loss, so can waste bandwidth and contribute towards congestion; ii) it fails to take advantage of available bandwidth to improve the quality of experience for the user/avatar; iii) it has a default absolute rate limit (throttle max) of 1.5Mb/s with a user settable maximum limit of 3Mb/s, regardless of available bandwidth, such as the 100Mb/s plus found on local area networks – a typical campus scenario. The Mongoose client [29] addresses problems (i) and (ii).

With respect to (iii), a particular problem caused by the conservatism of the inbuilt possible maximum throttle values is the significant delay encountered when initially downloading a virtual world from a server to the client. Figure 4 shows a range of initial download times for Cathedral Island, a 3 * 2 OpenSim mega-region for a range of throttle settings.

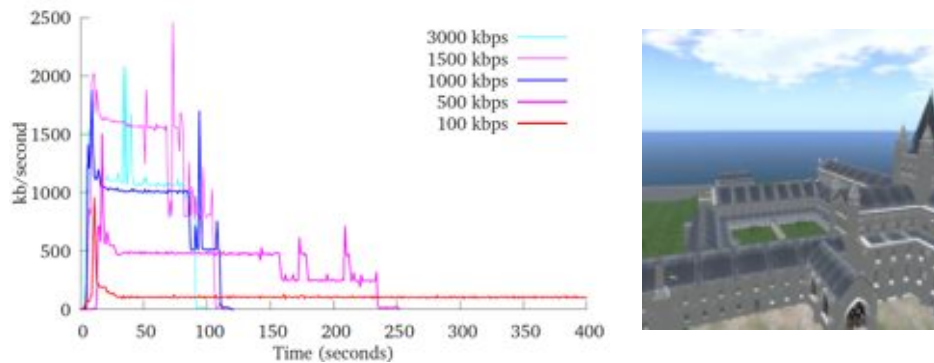


Figure 4: initial download times by total throttle for Cathedral Island

When set to the lowest likely to be encountered using an ISP (500Kb/s), it takes over 4 minutes; at the best available throttle value of 3Mb/s it takes 1.5 minutes. It would clearly be beneficial to develop OpenSim clients and servers to allow for significantly higher bandwidth to be used where it is available, as is usually the case on local area networks and wide area academic networks.

3. Towards the 3D Immersive Web

Unlike Second Life, OpenSim is very much focused on the idea of the 3D Immersive Web: “OpenSimulator lacks support for many of the game-specific features of Second Life (on purpose), while pursuing innovative directions towards becoming the bare bones, but extensible, server of the 3D Web” [15]. Emerging standard efforts to support interoperability of virtual worlds include MPEG-V [28] and the IEEE Virtual Worlds working group P1828 [29]. Over the next few years as the computing stock is upgraded the infrastructure to support immersive 3D applications will improve. Virtual Worlds have the potential to play an important role in facilitating the creation of 3D applications and in making them accessible as an extension to the existing World Wide Web. For this to happen they need to be seen not as a 3D alternative to the 2D Web but rather as an extension of the existing web. If Virtual Worlds are seen as a component that contribute to the extension of the web into three dimensions, then the walled garden approach adopted by Second Life appears less appropriate than the OpenSim approach of developing a toolkit for serving 3D applications. It should be possible to move seamlessly from the Web to a virtual world environment and back again. Getting from a Virtual World to the web is one of the strengths of OpenSim. Links to web pages can be embedded on the surface of objects and launched from scripts. They can be viewed in an in-world browser or an external browser. Thus the 3D world can be an interface to 2D Web resources. Moving from the 2D Web to the 3D world is more problematic. It can work in two ways. Either the browser opens a separate 3D client and communicates details from the web page to the client to allow it to connect to the appropriate virtual world or the browser has a plug-in which handles virtual world content. There have been projects for both approaches however to date they have either been incomplete or proprietary, so there is no readily available way to move from the

web to a virtual world, and achieving this must be a research priority for wider adoption of virtual worlds in education.

4. Programmability

As part of its compatibility goals OpenSim has carried over support for Linden Scripting Language (LSL [30]) from Second Life. LSL is very good at the job it was designed for: adding basic interactivity to individual objects within a scene. If more complex behaviour is required LSL can be used but the process is not simple. For example, LSL scripts can only communicate with each other via chat requests. As such all processing for one script must be done in one single text file. This makes writing and understanding complex LSL code hard to do. There is also no support for referencing third party utility libraries. When creating more substantial software for interactive learning environments such as virtual laboratories LSL is far from adequate. In addition to lacking the expressive power of object-oriented or declarative languages there is no support for development environments, debugging, libraries, code packaging, and IDE facilities such as dynamically loading new code into a live environment for testing.

External Mini Region Modules (XMRMs) are a scripting extension for OpenSim. Their purpose is to give developers a powerful way of programming content that exists within the virtual world. Scripts are written as external libraries in C# and loaded via short in-world scripts pointing to their location. The external libraries can be re-compiled and re-loaded in-world without having to shut down the server. Scripts can control the appearance, characteristics and position of objects as well as interacting with avatars and the terrain. One of the limitations of LSL is that it is designed so that scripts only affect the object they have been placed in. Manipulating several objects at once is difficult using traditional LSL mechanisms. XMRMs do not suffer from this limitation; the entire scene graph is available to them. They have all the powers of more traditional, in-world, scripting mechanisms but the fact they can be written externally using an IDE opens their scope.

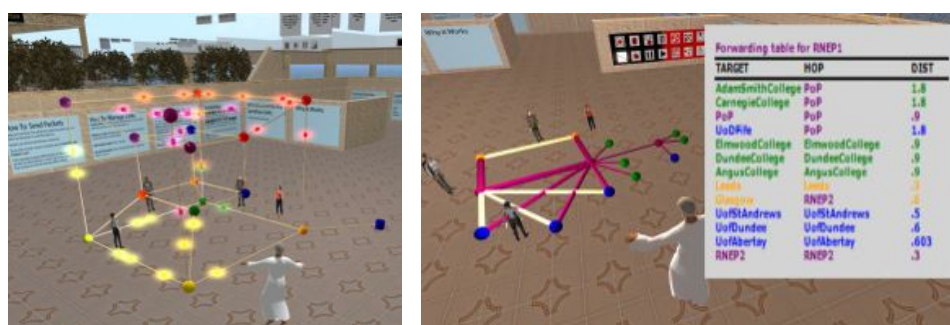


Figure 5a and 5b: Scenes from Routing Island

Routing Island illustrates what can be achieved by programming with XMRMs [1, 31]. It is a configurable, interactive simulation of either Link State or Distance Vector routing. Once in-world users can create network topologies, run their chosen algorithm across the topology and alter their topology and watch the results in real time. Figure

5a shows an Internet core conceived of as a hypercube; Figure 5b shows a situation where students have modelled part of their local metropolitan area network in routing island.

These simulations also allow students to view the forwarding table for nodes and save and load topologies. Different configurations allow the simulation to run as a personal sandbox, a shared, collaborative sandbox, a static demonstration or as an interactive, pre-recorded demonstration. It was created entirely using XMRRMs. It uses external libraries to read configuration files and do dependency injection late coupling for different configurations. It takes XML configuration files which allow dozens of separate control variables to be set to control behaviour. The simulation itself is split into multiple separate libraries. It is extensible and features its own plug-in mechanism allowing new algorithms to be written and tested on the system without having to alter any other part. All this development is significantly outside the scope of standard LSL. Even if using an external HTTP server to do most of the processing the complexity of the system would be prohibitive. XMRRMs made it possible to develop Routing Island using standard software engineering methodologies to manage the complexity.

5. Case Study: Linlithgow Palace

Considerable effort is needed to deploy an immersive learning environment compared with an educational web site, even within the confines of an educationalist's own institution. Deploying a substantially crafted virtual world into a different institutional setting, where there are other educational contexts in terms of curriculum, classes and age groups raises further challenges. We give an account of an example - Linlithgow Palace - that involved multiple inputs from various contributors, aimed at the primary and secondary education sectors in Scotland.

An OpenSim-based 3D reconstruction of Linlithgow Palace was installed in a computer lab at the local school, Linlithgow Academy, effectively combining cultural heritage, educational activities and virtual worlds. Linlithgow Palace was the birthplace of Mary Queen of Scots and was once lived in by successive Stewart kings. The preserved monument of the Royal Palace can be visited in a picturesque park setting overlooking Linlithgow Loch. The development of the reconstruction (Figure 6) was a collaboration between historians, computer scientists, educationalists and graphics designers.



Figure 6: Reconstruction of Linlithgow Palace in the 16th Century

The motivation behind the Linlithgow deployment was to help to support the forthcoming teaching of Kings and Queens of Scotland within the history department at

Linlithgow Academy. This fits well with the new national Curriculum for Excellence and its aim to explore topics in a local context to bring them to life. The Curriculum for Excellence [32] promotes exploratory learning and aims to move away from the traditional learning environment to incorporate planned and spontaneous play, which are well supported by the immersive environment offered by virtual worlds.

The original plan, based on previous experiences of adequate graphics capabilities in PCs, and blocked ports on firewalls, was to take an OpenSim server and clients into the school. However it was found that the school systems were able to work effectively with the Virtual World technologies and the reconstruction. An OpenSim server was installed on the school application server and modified clients were installed on 20 PCs in a computer laboratory. Whilst the wide area network infrastructure and local government firewalls normally prevent access to virtual worlds, social network sites and a host of other web resources, the flexibility of the OpenSim architecture meant that the local school infrastructure could be used.

Pupils from Linlithgow Academy had the opportunity to interact with the virtual reconstruction of Linlithgow Palace in June 2012. Linlithgow Academy has over 1,600 students. The reconstruction was advertised to all classes, and a PowerPoint presentation was displayed on the school information board. Over 100 students actively interacted with the Virtual World during scheduled and drop-in sessions. On the day members of staff from the School of Computer Science and representatives from Education Scotland and Historic Scotland [33] engaged with the students during the sessions.

Pupils produced artwork prior to the event. This had been organised and scanned by the school's History Department, and then placed within the reconstruction in the form of a web gallery to include user generated content and engage them with the forthcoming event. During scheduled activities more than 60 pupils completed an optional task sheet to reveal a key date and a special location within the palace. They achieved this by locating facts in-world and interacting with historical characters in locations throughout the virtual palace. Finally they voted for their favourite artwork in-world and used three imaginative words to describe the reconstruction.

Another exercise in student engagement made use of chroma keying. It was discovered during the deployment that some students from the school don historical costumes and work as volunteer tour guides at the Palace as it is today (see Fig.7).



Figure 7: School students working as tour guides

A number of these students subsequently took part in creating video images. These volunteers wearing authentic costumes were filmed against Education Scotland's green screen during a visit to the present day monument (see Fig. 8). The resulting images were then imported into the reconstruction, which placed the guides in their correct context of the Palace as it was in 1567, albeit as rather ghostly presences (see Fig. 8).



Figure 8: Filming the tour guides using chroma keying and the resulting import into the virtual world

Outwith the scheduled sessions pupils and staff had the opportunity to drop in for free form explorations. The sessions proved very popular and created much excitement within the Library where the event was taking place.

Although scheduled events took place in an enclosed area within the Library, two additional areas were provided with more open space allowing staff and pupils, who were not part of the scheduled sessions, an opportunity to use the reconstruction. These areas made use of monitors and projectors displaying the virtual reconstruction where users could explore the Palace using Xbox 360 controllers, and Xbox 360 Kinect (see Figure 9). Several interesting observations were made. The Xbox controllers and Kinect were very popular and proved more intuitive than using the keyboard and mouse. Students were clearly already used to and adept at using such game controllers. Students were very interested in interacting with objects and other users in-world.



Figure 9: Digital native with Xbox controller; Calibrating Kinect interface

In summary, this immersive educational activity provided a focal point which energized pupils in investigating and exploring events, life and personalities that would have filled the Palace some 500 years ago. In doing so, they in turn enriched the reconstruction as an educational resource and through the medium of film and images were able to communicate with their peers. We found the existing technologies were able to support these activities and therefore this pilot study will be extremely useful in providing insights for use in future educational settings.

6. Conclusion

Virtual Worlds have great potential for educational use, as is evidenced by the growing range of subjects they have successfully been used for. In particular we have noted how OpenSim has come a long way from Second Life in terms of its capability for supporting educational activities. From the point of view of more sophisticated content creation and interactivity better programmability is needed as is illustrated by the use of XMRRMs in Routing Island. We have focused on some further considerations as to how virtual worlds could be adopted more widely in education: user guidance for management, revised communication protocols and bandwidth constraints and integration with the Web. We have featured a case study in the area of cultural heritage and history: Linlithgow Palace. The young learners were digital natives and readily engaged with the Virtual World, without thinking of it as an exploratory learning resource, supporting Kolb's higher order learning activities [21], although that is exactly what it is intended to be. However, considerable effort was needed to support the deployment, especially when compared with using an educational web site. Teachers and local ICT technicians at Linlithgow relied on the expertise of the project team to install the server software, connect the user interfaces, import the pupils' art work into the Virtual World and configure user names and avatars. In some ways, the question is: how do we make the support team superfluous? A means of accessing the Palace across the Internet would remove the need for local installation – hence the comments made earlier about the poor suitability of the current OpenSim communication protocols in terms of reachability on the global Internet. Teachers and lecturers could learn to create users with avatars and allocate land through advice from the management user guidance methodologies described in section 2. Future work includes streamlining support for deployments in educational settings and encouraging educators at all levels of education to bring Open Virtual Worlds into the learning technology mainstream.

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BuzzBoards Demonstration - an X-Reality Toolkit for Creating Immersive Reality Educational Laboratories

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Overview. One challenge facing Immersive Learning environments is how to support teaching topics that involve laboratory activities and the construction of physical systems, especially in environments comprising teams of geographically dispersed students. In this demonstration we will present a tool kit designed by the authors called *BuzzBoards* that provide a set of network based modules, and their virtual counterparts, that can be assembled by students to build mixed reality systems. The toolkit is based around the *Internet-of-Things* enabling students to build embedded computing systems ranging from phones, through MP3 players to robots. The principles are based on deconstructionism whereby primitive functionalities of commonplace electronic and computing devices are decomposed into a set of network based soft & hard services which are shared within connected virtual environments and reassembled by students. We propose to bring this toolkit to iED Europe Summit and demonstrate it being applied to the assembly of mixed reality educational laboratory system. The demonstration will complement a conference iED paper, “End-user programming & deconstructionalism for collaborative mixed reality laboratory co-creative activities” submitted by Anasol PEÑA-RIOS, Vic CALLAGHAN, Michael GARDNER and Mohammed J. ALHADDAD [1] which presents a model that allows geographically dispersed students to collaborate on mixed reality laboratory activities using combinations of cross reality (xReality) and virtual objects.

1. Introduction

Supporting physical laboratory work within immersive educational environments is very challenging. Current research on laboratory activities for distance learners has mostly focused on simulations, virtual laboratories and remote laboratories where there is no interaction with real equipment and the activity is performed with idealized datasets and restricted collaborative interaction. Interaction with physical systems is a vital part of science & engineering students' educational experience.

In our demonstration we will show an immersive education environment can be created to support laboratory teaching based around the *Internet-of-Things*, a computing technology that concerns the interconnection of countless networked embedded computing devices. In this world, almost everything in a person's life can be

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interconnected from bathroom scales through cookers to cars, the behaviour of which can be orchestrated by people or their agents. Some estimates of the Internet-of-Things market suggest that by 2020 it could be worth between 22 billion and 50 billion dollars made up of some 16 billion connected devices which, in turn, will drive the need to educate students in these skills. The *Internet-of-Things*, like Immersive Education is a network based technology. Thus this is a fitting topic to begin an exploration of how immersive education environments might support science and engineering laboratory work.

2. The Demonstration - The BuzzBoard Mixed Reality Toolkit

At iED 2012 we propose to demonstrate the *buzz-board* toolkit which is an open-system comprising some 30 pluggable hardware boards that can be interconnected together to make a variety of “*Internet-of-Things*” applications, see figure 1 for a few of these modules.



Figure 1. *Buzz-Board* Examples - From Left to Right Audio, Midi, KeyPad, Base (Processor), LED & Network

Notice how these modules have through-connectors enabling the units to be assembled (reconstructed) in various combinations, thereby allowing different functionalities and physical forms to be built. For example, a wheeled robot to be constructed (see figure 3a). In terms of use in an immersive learning environment the key feature is a network connection (based on I²C) that threads through each board allowing the wider Internet (and immersive environments) to be notified what boards are plugged together and to identify what software functions exist for that module (plus other status information). The same principle is applied to the software (virtual) counterparts of these modules, thereby allowing a mix of soft and hard objects to be assembled by students to share connectivity and status within every single immersive environment, thus forming the building blocks of collaborative mixed reality immersive reality laboratory educational environments. The entire system is modularised and even the main processor board (the heart of the *Buzz-Board* system) is designed in such a way as to accept a daughter mezzanine board containing the processor of choice. One variation of this mezzanine board is a version that is pin compatible with the industry standard mbed (see Figure 2a) whilst another is aimed at the newly emerging \$25 Raspberry Pi (see figure 2b). Other processors that the *Buzz-Board* system supports are AVR (Arduino), Coldfire, 68K, and PIC processors. As explained in the companion paper being presented to iED by PEÑA-RIOS [1], the above model is based on concepts of constructionist and co-creative learning.



The mBed is based on the ARM Cortex-M3 Core running at 96MHz, with 512KB FLASH, 64KB RAM and various interfaces including Ethernet, USB Device, CAN, SPI, I2C

Figure 2a. mBed



The Raspberry Pi is based on an ARM1176JZFS, running at 700Mhz, with a Videocore 4 GPU. (BluRay quality playback) in a Broadcom BCM2835 SoC. The current best specified model has 256Mb RAM, 2 USB port and an Ethernet port.

Figure 2b. Raspberry Pi

3. The Immersive Education Environment

Our Immersive Educational Environment takes the appearance of a special virtual reality environment in the form of a study desk with an inbuilt semi-spherical sectioned screen that gives the student an illusion of being in the same room with other students (see figure 3b). The idea is that geographically dispersed students using these desks can come virtually together to collaborate in mixed reality learning exercises (eg. building a *BuzzBoard* robot). The iDesk supports both students and teachers using variety of agents to mediate both the users and learning content. The desk is not practical to transport and will not be included in our demonstration (we will simply use a flat portable screen to illustrate how this system works). A more detailed account is given by one of the authors, Anasol PEÑA-RIOS, in another iED paper [1].



Figure 3a. The Buzz-Board Desk Top Robot



Figure 3b. The Immersive Learning Desk

4. Summary

At iED’12 we will demonstrate how the *BuzzBoard* toolkit we have designed and built (comprising some 30 modules) is able support teaching and learning of laboratory based activities inside an immersive educational environment. For practical reasons we will demonstrate the operation of mixed reality using a small portable screen (our large table is impractical to transport) but we support the wider demonstration by a full iED paper and posters.

[1] Anasol PEÑA-RIOS, Vic CALLAGHAN, Michael GARDNER and Mohammed J. ALHADDAD: “End-user programming & deconstructionism for collaborative mixed reality laboratory co-creative activities”, iED Europe Summit 2012, Paris, France.

The Smithsonian Latino Virtual Museum: Redefining Curatorial Practices in the Age of Immersive Education

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Abstract. This presentation gives an overview of the Smithsonian Latino Virtual Museum (LVM) focusing on how the Smithsonian Latino Center is utilizing transmedia strategies for art experimentation as part of a curatorial process in redefining immersive education and presenting art exhibitions and installations in virtual spaces. Ms. Carrillo and Ms. Herrera will offer conference attendees a preview of the latest 3-D concept for art installation and exhibition using Unity 3-D. The showcased virtual artwork is a re-interpretation of the original painting *Harvest* by Chicago-based Cuban-American artist Paul Sierra.

Keywords. 3-D Art Installations, Smithsonian Latino Virtual Museum, cultural dimensions of immersive educational technology, Latino art, virtual exhibitions, transmedia

Introduction

Since its launching in 2006, the Smithsonian Latino Virtual Museum (LVM) has become the site for experimentation in immersive education trends combining the latest technology with the humanities and the sciences. As the first virtual museum of its kind within the largest complex of museums in the world, LVM has been at the forefront of translating curatorial practices to a new medium. In this particular collaboration between the Smithsonian Latino Center and the University of Notre Dame's Snite Museum, we have approached the artwork of Paul Sierra from a new perspective to [re]create his painting *Harvest* in the collection of the Snite Museum as an immersive 3D experience. The new *Harvest*, is a work of digital art created by the artist and translated by the LVM team that allows the viewer to achieve the sought after entering the frame and immerse yourself in a new pictorial space. This new collaboration affords many possibilities for collaborative work with artists and institutions. The results are in the words of the artist "a new art and cinematic experience," a new frontier in Latino art now.

The Smithsonian Latino Virtual Museum ([LVM](#)) is an offering of bilingual, mixed-media experiences and educational online resources of the Smithsonian Latino Center (SLC). Its mission is to highlight and make known the vast and rich collections,

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research and scholarship, exhibitions and educational activities of the Smithsonian Institution as they relate to U.S. Latinos and Latin America.

As a pan-institutional online museum showcasing Latino and Latin American collections and research holding in the museums, libraries, archives and research units of the Institution, LVM has exploited the evolving digital technologies (since its founding in 1999 as an online 2D gallery space) of the last thirteen years to broaden access and to attract new local, national and international audiences in order to further increase and diffuse knowledge about U.S. Latino and Latin American holdings.

The history of LVM is one parallel to evolving new media and communications technologies, innovation and experimentation to find new ways to make museums and museum collections accessible and relevant to all. As a museum without walls within the largest consortium of physical museums in the world (The Smithsonian Institution), LVM is unique in harnessing the intersections of emerging digital technology with research, knowledge and education in the arts, culture and science.

Making full use of the latest digital developments, LVM has experienced first hand the evolution of science and technology with its own design and infrastructure: from html computer language, to flash, to Web 2.0 and Web 3.0 platforms of virtual worlds in *Second Life* to more recent experimentation with trans-media, immersive 3-D virtual reality, open source virtual worlds, 3-D PDFs, and Augmented Reality (AR) applications to name just a few. LVM in and of itself reflects the constant of change and the increased permeation of technology in our contemporary daily life. Today, LVM is accessible through desktops, laptops, and mobile devices like smart phones, tablets, iPads and the kind.

LVM, as an online educational outreach and resource created to enhance visitor's knowledge, understanding, and appreciation of U.S. cultural heritage, devises and utilizes innovative and engaging online experiences to increase the knowledge about Latino history and experiences in the United States and the many links to countries of origin in Latin America. LVM seeks to immerse audiences in the untold stories of American Latino history; to explore Latino cultural identity; to experience Smithsonian Latino collections and bilingual resources; to witness vibrant cultural cross-sections; to discover, collect and analyze the worlds of pre-Columbian cultures as a LVM Eco Explorer; and to learn about land and water relationships and how we impact the environment, among others.

Since the mid-1990s when networking technologies materialized into the Internet, education (as well as society) has been transformed. As an educational museum, LVM makes use of the power of technology to deepen our knowledge, to reach and to provide audiences with dynamic educational experiences and cultural content. As an avatar-based 3-D virtual world environment in *Second Life* and in other virtual platforms, LVM carries out immersive learning activities in a 3-D format. For the younger generations, LVM becomes a tool for effective learning beyond the classroom walls by engaging teachers and complementing their efforts in developing new and exciting hands-on interactive education enriching the academic experience of learners through virtual and real time field trips, expeditions and explorations.

What LVM does in the field of education is to engage this gaming technology and interactivity to develop new ways of presenting Smithsonian objects, artifacts, artworks and contextualize them creating a myriad of connections and links which in turn opens up expanding spaces for new interpretations, new visualities and new knowledge. In addition, the interaction with digital audiences expands exponentially the Smithsonian experience of beloved treasures in what has been affectively dubbed the “Nation’s Attic” beyond Washington, DC confines.

For the Smithsonian Institution with millions of significant objects in storage, the digital museum model opens up access to its important yet unseen collections. As a dedicated museum for Latino and Latin American pan-institutional collections, research and specimens and artifacts, LVM brings together in one site art collections from the Smithsonian’s American Art, American History, Hirshhorn, Cooper-Hewitt, Archives of American Art; research findings from Natural History, the Tropical Research Institute and the Environmental Research Center; cultural artifacts and objects from American History, American Indian and Natural History; and the valuable music instruments, archives, oral histories and recordings of American History, Center for Folklife and Cultural Heritage and American Indian museums.

In the visual arts, LVM groups together information on the Latino and Latin American Institution’s collections and holdings including artworks, archival collections and library holdings. As a grouping, these collections complement each other to form a more comprehensive view to the contributions of Latino artist and Latin American artists in the US to the overall make-up of American culture. Artworks, oral histories and papers of artists reveal creative ideas, artistic issues and the historical context in which artworks are created. In 2011 the SLC commissioned a 195-page survey report title *Smithsonian Institution Latino, Hispanic and Latin American Art Collection and Resources*³ to serve as the foundational reference guide for research, interpretation and representation including in cyberspace. [Click here](#) to view the guide

LVM utilizes cutting edge technology to transform digital images of artworks into tridimensional (3-D) spaces for audiences to enter the picture frame, as well as sculptures and installation art. In its overall presentation, LVM looks to break away with the gallery model or the “white cube” and explore new ways of curatorial representation and interpretation providing instead of a visual learning an experiential one in which audiences and visitors explore at leisure what the artist and its creativity conceived and envisioned.

In its mission and quest to increase and diffuse knowledge, the LVM works with outside strategic partners to further augment the efforts being made by SLC in the areas of representation and interpretation of Latino collections and resources as represented in this current project collaborative with the University of Notre Dame and the Snite Museum with regards to the work of Cuban-American artist Paul Sierra.

³ Olga U. Herrera, “Smithsonian Institution Latino, Hispanic and Latin American Art Collection and Resources,” Report. Washington, DC: Smithsonian Latino Center, November 15, 2011.

As an avatar-based 3-D virtual world experience, 3D simulation or game environment, LVM generates identity and builds community in many ways while making important inroads. In science education, for instance, it utilizes Smithsonian science collections and resources to create interactive interventions with curators and scientists to awaken scientific inquiry in young minds. The intersection of science and technology comes together in a series of environmental explorations and excavations with geographical destinations as varied as the archeological sites of La Venta and Tres Zapotes, the Panama Canal and its locks, the Amazon Basin and the Chesapeake Watershed where one can become an Eco Explorer in an interactive immersive environment equipped with exploration and scientific gear to learn about biodiversity, the environment and ways to sustain our natural resources for future generations.

LVM in its support of a young K-12 community of future scientists and researchers effectively utilizes GPS technology, topographical radars, and interactive maps to guide explorers in their expeditions, investigations, and knowledge.

In the larger scheme of community building, LVM is the must stop for experiencing the confluences of Latino cultures in the United States. With its emphasis on access framed within a model of forum, LVM creates spaces for interaction, dialogue, reflection through live public programming that range from cultural celebrations, performing art concerts and open microphone readings of poetry and literary arts to video and oral histories.

LVM is the site to dance your night away with Latin Jazz, Son Jorocho, Salsa rhythms among others preserved by Smithsonian Folkways recordings and music collections. It is also the site to become acquainted with U.S. evolving cultural heritage and traditions such as *Dia de los Muertos*; to listen to poetry and literary readings by up-and-coming poets and writers in the different regions of the country; to see the new emerging art and its creators and connect with global audiences from all corners of the globe. Come and experience with us all that LVM has to offer!

1. Virtual Installation/Demonstration

The Smithsonian Latino Center has been at the forefront in redefining representation and interpretation of Smithsonian Latino and Latin American collections and resources via its Latino Virtual Museum Initiative (LVM), a model for transmedia experiences leveraging gaming, simulations, virtual worlds, augmented reality, 3D object artifacts, and animation shorts.

In this presentation Ms. Carrillo and Ms. Herrera will give an overview of LVM with a focus on how the Smithsonian Latino Center is using transmedia strategies for art experimentation as part of the curatorial process in redefining and representing art exhibitions and installations in virtual spaces. In addition to presenting several examples of previous 3D art representations based off of Smithsonian collections, Ms. Carrillo and Ms. Herrera will give attendees a preview of a new 3D art concept for installation and exhibition based on experimentations using Unity 3D. The showcased

piece is an interpretation of the original painting *Harvest* by Chicago-based Cuban-American Artist Paul Sierra.

Sierra: *Having been born in Cuba but living most of my adult life in the U.S, I find influences from North American art and culture intertwined with my artistic and emotional links to my Latin roots. Art has provided me a means for leaving the past behind; not getting lost in the limbo between the old and the new. Art is of great help to the immigrant, allowing him to transform the chaos of his life into a positive vision.*

Ms. Carrillo will briefly discuss the conceptual design process that involved a multi-disciplinary team of artist, museum professionals, researchers, technology and but also the archivist who introduced him to the experimental artwork being developed under the Smithsonian Latino Virtual Museum.

Carrillo: *I will discuss the importance of representation and interpretation of U.S. Latino Cultural Heritage through the lens of transmedia experiences. From the cultural institution perspective, these new approaches to curation and interpretation by artist, curator and audience from within the museum walls is still for the most part uncharted territory when using innovative new technologies. The use of artificial intelligence to represent a figure from a painting, for example, lends itself to a multisensory layered user experience. This process redefines curatorial practices in the age of the social web.*

Attendees will experience first hand some innovative approaches to curatorial practices in virtual spaces from the lens of representation and interpretation of Latino Cultural Heritage via immersive 3D learning experiences. Ms. Herrera and Ms. Carrillo will present samples including the new highlighted artwork *Harvest* via an LCD projector and speakers. Volunteers from the audience will be encouraged to come up and navigate the 3D installation on their own.

The presenters will conclude with highlights from an interview between Mr. Sierra and the Smithsonian-University of Notre Dame team responsible for the artistic motivation behind the 3D interpreted simulation. This will be the first formal international launch of this experimental 3D artwork currently supported under a Smithsonian Latino Center partnership with the University of Notre Dame and its Snite Museum.

1.1. Demonstration Requirements

For the team to successfully present this virtual installation, the following will be required:

- Team will bring a Macbook pro with LCD adapter; but we will require an LCD projector and screen
- need Wifi access or internet
- need speakers to connect to Macbook pro
- Aside from showing live demonstration in Unity 3D, we will first show a few slides in ppt format

- As back up to ppt slides: Poster stand for use during demo to show other experimental artwork that led to this type of installation
- Poster stand for poster demo



Figure 1. [Click here](#) to view the live installation in Unity 3D; inspired by the work of Paul Sierra

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Abstract: This essay describes the evolution of the Virtual Harlem Project as envisioned by Dr. Bryan Carter. This project, used to teach African American literature classes, has evolved to include a multidisciplinary team, and is currently situated in the virtual world of Second Life. The current platform, however uses outdated code and the graphics are not at the resolution of current videogames, therefore the project is going under a remarkable revision that will teleport it into the 21st Century and beyond. Along the way, this essay discusses the innovations involved in creating this project, describes a case study of a recent African American literature class and explores the theoretical reasons behind using a massive multi-user object oriented environment in a literature course.

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DR. BRYAN CARTER

Virtual Harlem: An Innovative Past, An Evolving Present and an Exciting Future

Virtual Harlem: An Innovative Past

The original Virtual Harlem was conceived by Dr. Bryan Carter as part of his graduate work at the University of Missouri-Columbia in 1996, and developed by the Advanced Technology Center there who assisted him in designing it as a collaborative Virtual Reality (VR) environment and learning simulation in which participants learned about and experienced the Harlem Renaissance, supplementing real world courses about the subject. The Harlem Renaissance was a unique period in American history that occurred in the 1920's, just after the end of World War I. It was a time when Langston Hughes, Eubie Blake, Marcus-Garvey, Zora Neale Hurston, Paul Robeson, and countless other African Americans made their indelible mark on the landscape of American culture. This is a time when African Americans made their first appearances on Broadway; chic supper clubs opened on Harlem streets; riotous rent parties kept economic realities at bay while the rich and famous, both white and black, attempted to out do each other with elegant, integrated soirees (Lewis, 1979, from the back cover of the paperback edition). Until recently, however, this historic Harlem has been a forgotten site of American cultural history. Even today, its history remains largely unknown except by those students enrolled in specialized courses or who experience only the most recognized figures and events. Virtual Harlem is a digital representation of 1920s Harlem, N.Y., at the height of the Harlem Renaissance. The current model, currently located in the virtual environment of Second Life, includes about 10 blocks of Harlem out of the 20 or so that are associated with it during the Renaissance. Virtual Harlem includes buildings such as the Apollo Theater, the Marshall Hotel, and the Cotton Club. As visitors move through the streets, they can encounter several famous figures as well as several residents of 1920s Harlem. Participants in this experience can watch cars and trolleys move up and down the streets or even hop aboard one for a ride through the city.



Figure 1.

There are several features of the Virtual Harlem project that contribute significantly to its potential as instructional technology. From the point of view of its subject matter, Virtual Harlem is a learning environment in which participants virtually experience a literary, dramatic, and visual history centered in Harlem, New York during its "Renaissance" period. From the point of view of the mode of learning, Virtual Harlem is an environment that enables a subject like the Harlem Renaissance to be

studied by *modeling its historical context as a dynamic system of social, cultural, political, and economic relations*. Additionally, persons interested in the Harlem Renaissance or Harlem, N. Y. can contribute to the content already there, thus enriching the overall experience for all who visit the environment. Hence, Virtual Harlem was designed as an informal learning environment facilitated by a journey of discovery by immersing participants in a simulated Harlem Renaissance that compliments a variety of disciplines. Because of this fundamental structure, a participant may potentially 1.) read about the Harlem Renaissance from a textbook, novel or essay, 2.) Experience it in an immersive environment, 3.) Reinforce learning through the completion of some sort of project that contributes to the overall content 4.) Interact with others who are simultaneously experiencing the environment, through classes, role-play, and events, both social and formal.

At the beginning of this project, nine universities and one super computer center were associated with the Virtual Harlem project: University of Illinois at Chicago (UIC), the University of Central Missouri (UCMO), the University of Missouri-Columbia (MU), the University of Arizona (UA), Columbia University (CU), Växjö University, Sweden, Morgan State University (MSU), Vassar College (VC), the Sorbonne IV, Paris, and the SARA Super Computing Lab in Amsterdam. Several of these universities were subsequently linked to each other for discussions of the Harlem Renaissance in connection with courses they developed. This Virtual Harlem collaborative learning network (CLN) also had the potential to introduce learners to **systems thinking and visual thinking**, two evolving modes of intellection that have come to the forefront as educational goals due to the increasing availability of computer assisted learning.

When the project was first developed, the digital model of Virtual Harlem could be accessed through several delivery systems. A 3D version of Virtual Harlem was available online and several videotapes of Virtual Harlem tours were available upon request. The fullest version, the immersive CAVE environment, required visits to a lab such as UIC's Electronic Visualization Lab or the SARA Super-Computing Lab in Amsterdam to experience the virtual reality scenarios. Every effort was been made to make Virtual Harlem available for the common PC or digital console. Thus, the search was on to find a collaborative, online, cross-platform environment that could house the Virtual Harlem project and the goals associated with it.

Background on Virtual Reality for Learning

Virtual Reality (VR) is the use of special hardware and software to generate a simulation of an alternate world. It enables the manipulation of information in a similar way in which objects are manipulated in the real world. Instead of passively viewing static text and images, VR facilitates interaction with 3D graphical objects that can be manipulated directly, at will. VR is a subset of computer graphics and of human-computer interaction. It is what Dr. Thomas Furness called "the last few inches" that keep us from attaining a natural and intuitive interface with computers (Hamit). There are three common types of VR systems including *Desktop VR*, *FishTank VR*, and *Full Immersive VR*. Desktop VR systems use a conventional computer monitor to display the virtual world. Conventional peripheral devices (e.g., computer mice) are typically used to navigate the virtual world. Desktop VR lacks the full immersion capabilities of more advanced types of VR systems. However, desktop VR is still popular because it is relatively inexpensive compared to other types of VR systems. Desktop VR is typically developed for multi-player video games.

Fish Tank VR systems integrate a monitor display into special glasses, typically called LCD shutter glasses that create an illusion of three-dimensional space. This type of system is more advanced than desktop virtual reality because the glasses fully surround the user's visual spectrum with a digital three-dimensional space. *Full Immersive virtual reality* systems allow users to fully experience the virtual environment from a first-person viewpoint. True immersive VR is typically done with special peripheral input devices that the user wears to feel completely surrounded by virtual space. For example, for an immersive VR experience, a user may wear data gloves, a full body suit embedded with biosensors and a head-mounted-display as a composite set of peripheral devices. The biosensor embedded body suit may be designed to automatically detect human physiological data and tailor the VR experience to the user. The data gloves, worn on each hand, provide tactile feedback to facilitate a sense of picking and lifting objects that have varying weights. The head-mounted display, like in a Fish Tank VR experience, provide a 3D rendered visual environment that completely surrounds the user's visual spectrum. As the example presents, this is more advanced than fish tank VR because the person's eyes, hands and body can have sensors that trigger the user's senses and make the user's

interaction with virtual objects seem even more realistic. However, full immersive VR is considerably more expensive than the other two types of VR systems.

The origins of VR for learning stem from several concepts developed over a long period of time (Pantelidis) and its origins at the time of Thomas Edison's 1889 invention of the kinescope. The kinescope, the parent of modern pictures, was a peep-show device where up to fifty feet of film ran continuously between a magnifying lens and a light source. By 1910, Thomas Edison and others were producing educational films and selling them to school systems (Saettler). The first attempts at simulating life-like environments for educational purposes were with the 1928 airplane simulator for the Link Trainer. The Link trainer was used during World War II for teaching pilots proper procedures of instrument flight, such as using a radio range for determining an airplane's position in bad weather. Using this type of simulator, an operator sat at the desk and transmitted radio signals, that "pilots" in the Link heard through their earphones. By the 1960s, several people had already developed head-mounted systems where users could look around computer-generated rooms. True VR programs emerged in the early 1970s when users could interact with virtual environments (Hamit). It is only recently that VR applications/systems have become usable and widely accepted by other industries besides the military; education, film and television and the auto industry are among those who have adopted VR as part of their workflow or training initiatives.

Training and learning are important application areas for VR technologies. Learning through the use of VR allows learners to construct their own abstract worlds, or experience those created by others, giving them first hand experience in the transfer of two-dimensional knowledge into three-dimensional knowledge. In other words, the potential value of VR for education lies with its ability to provide immersion of the user in either realistic novel or abstract environments. Immersion allows the user to experience, interact with, contribute to, and discover digital knowledge first hand, while the manipulation of the verity of the virtual world allows the user to make visual or kinesthetic relationships to help understand the real world or concepts related to it. Finally, VR may bring information to the user, which is not normally available in traditional educational settings. Immersive displays, three-dimensional sound, synthetic smells, virtual feeling, and other types of virtual reality interfaces can be used to create realistic virtual environments that closely simulate real world environments in which students may be trained (Johnson et.al.). By interacting in this medium, students "learn by experiencing". Development of virtual worlds has been carried out by educators for use in schools by students for research purposes and on the Internet for the purposes of research and distance learning for over a decade (Doswell, Pantelidis, Rose, Thurman, Traub).

Researchers hypothesize that the richer the perceptual cues and multi-modal feedback (e.g., visual, auditory, and haptic) afforded to students in virtual environments, the easier it is to transfer virtually trained skills to real-world skills (Durlach). Preliminary evidence supports this conjecture (Pantelidis). However, virtual environments that include photo-realistically rendered objects and their real-world-like behaviors are not enough to be an effective training tool. The delivery of empirically researched instruction that facilitates and enhances human learning must be considered. There is considerable research on the problems that arise from unguided interactions within simulation-based learning environments and since interactive virtual environments typically incorporate simulations, such research is relevant to the better design of virtual environments for training (Rickel). For example, when students do not know how to complete a given task, the learning process can get bogged down while they are searching for some method of completing the tasks (Hill). If students do not have a clear understanding of the tasks being learned, they may perform them incorrectly without realizing it, and thus incorrect learning may take place. Furthermore, there is always a chance that they may acquire incorrect models of the system with which they are interacting (Self).

Education in Second Life

Second Life® (SL) is a Collaborative 3D Virtual Environment designed by and supplied from streaming servers owned by Linden Lab (TM) that actively supports human-human communication in addition to human-machine communication and which uses a virtual or 'synthetic' world as the user interface'. Launched in 2004, Second Life was one of the first collaborative, multi-user, cross-platform environments where users could build or contribute to the virtual world with tools built into the client. Ideally suited to facilitating Wenger's (2004) notion of 'Communities of Practice' that describes a group of people with a common interest, a shared history, shared sense of identity and a similar knowledge set that has been derived over time. Wenger also notes in his 2007 'Brief Introduction' that

“in pursuing their interest from within this domain, group members engage in joint activities and discussions, participate in social activities, help each other, and share information. They build relationships that enable them to learn from each other”. It is suggested here that social interaction between participants is almost inevitable within Second Life® in that the platform supports multiple communication channels across a broad spectrum, from asynchronous text messaging, synchronous Instant Messaging, synchronous public typed chat, distributable text-based Note cards, through to real time voice conversation in which it is possible to address an individual user in a private call or to address a group of almost unlimited size. Users can communicate with SL objects that have been scripted in Linden Scripting Language (LSL) to perform certain functions on touch such as dispense a note card or open a door. Similarly, SL Objects can communicate externally linking to web sources such as YouTube® to enable external data to enter the SL world. Communication is even possible between users who are logged into the environment with those who are not. In effect, communication channels that were once contained entirely within SL are now able to extend between both worlds synchronously.

Many teachers and parents frown on the use of video games in the classroom because they may possess a commonly held notion that games are fundamentally opposed to serious endeavors like learning; superfluous, frivolous, lacking morality, games are often regarded as violent in nature and are perceived to encourage aggressive, anti social and additive behavior or desensitized responses to scenes of violence as reported in “New Scientist” (2005). Notions such as these are not without substance and there is a lack of research to counter such arguments. Although there are a number of effective interactive educational titles, they are rarely used for an extended period of time and often they are “static” titles, that, when played once, often lose their luster because the game was finished, won or the goal was reached. What many have a difficult time understanding when trying to "categorize" Second Life, is that it is not a game. Virtual Worlds can be segregated from games by applying the “persistence test”. Virtual Worlds cannot be paused, they continue to exist and function dynamically whether the user is there or not (Bell 2008). Where games differ in so many ways regarding competitiveness, an "end-goal" or even coming to an end. Second Life is anything but that. When considering the positive attributes of Massive Multi-Player Online role Playing Games (MMORPGs) we find that “Gamers come to virtual worlds because in them they find more than a game, they find other gamers. They come not necessarily to compete with each other, but to collaborate with each other, to learn from each other, to profit from each other, to talk to each other in the environment. Players come to MMORPGs to interact with other players, and in that way, MMORPGs are a very special form of interactive entertainment, in that they derive their value mainly from the fact that there are other players there” and that there is so much more to do besides "win" the level (Ludlow & Wallace, 2006).

Games which possess an educational quality also termed “serious games” are becoming part of the future landscape for education, defined by Wexler et al (2007) as “an optimized blend of simulation, game element and pedagogy that leads to the student being motivated by and immersed into the purpose and goals of a learning interaction” and Hackerthorn (2007) as “a game which has enduring value beyond that of entertainment” going on to explain that for a game to possess enduring value it should demonstrate a direct relevance to the real world as opposed to being based in pure fantasy, preferably with an explicit connection to a real world system.

Translating this idea and the Virtual Harlem project to the learning possibilities of Virtual Worlds offers almost unlimited “teaching moments.” Second Life is an immense environment, once consisting of over 5 million residents from almost every walk of life, from around the world, to include a small cadre of educators that recognize how an interactive 3D environment can affect the educational experience in a positive way. Most educators have never experienced an interactive 3D environment where real learning can take place and the strive for authenticity is an ongoing battle in which credibility is the major stake.

MMORPGs are becoming ever more popular among adolescents and adults due to their social context, while at the same time offering an array of complex activities and objectives that players must accomplish in order to "succeed" in the game. With Social Networking Sites like Facebook being the starting point and collaborative video games like Halo or Call of Duty being the other end of the spectrum, Second Life is an ideal platform where there are elements of both. There are several recent studies that examine the teaching and learning potential of this particular genre of video game most specifically to teach science and physics (Recent University of Central Florida NSF grant award number 0537078). These efforts are important in that they suggest that there can be sound pedagogical

methodology incorporated into MMORPGs and that more researchers are exploring the potential of these environments. Constructivist learning theory is just one of the theoretical approaches that helps justify the expense associated with learning to navigate these micro-worlds.

The term "micro-world" was coined by Lloyd P. Rieber and is defined as "a small but complete subset of reality in which one can go to learn about a specific domain through personal discovery and exploration" (Rieber 1992). Furthermore, micro-worlds allow users to interact with others and build objects within the environment, thus adding to the interactive nature of the world. Through the creation of a number of environments where Rieber's son could determine his own direction, make decisions regarding his learning that changed based on the decisions he made, Rieber suggests that visually based virtual environments are an extension of constructivist learning theories (Rieber 1992).

Virtual Harlem Case Study – Machinima

Machinima is not an entirely new form of artistic expression. Introduced in the early 1980s through a variety of video games, multimedia creators used this form as a cost cutting alternative to high-cost 3D rendering platforms. There is no doubt, with the graphic evolution of video game engines and online virtual worlds that Machinima has solidified itself as an expressive way to explore film making within virtual environments.

One area where Machinima is just beginning to make inroads is in education. Academics have explored Performance Studies in a variety of disciplines since the early 1970s. Although hotly debated as an actual "field", the idea of "Performativity" as explored by Judith Butler suggests that "the reiterative power of discourse to produce the phenomena that it regulates and constrains" allows "actors" to understand the text as reality, performing it countless times through their actions thus increasing understanding of the text through their performance (Butler qtd. In *Identity: A reader*, 2000). Machinima helps address some of the criticisms in Butler's concept of performativity in that the space where the machinima is filmed adds to the overall understanding of the piece, along with how other actors are involved in the overall shot. Furthermore, the interpretation of those viewing the machinima, whether live or recorded, is in part dictated by their overall experience where hardware, networking and user experience all come into play as integral parts of understanding the text/machinima itself. Actors and or those producing the machinima/text are where this course deviates from most other composition courses. One important aspect of Butler's notion of Performativity is that of the actors understanding the text as reality. In a traditional literature class, of that which is read is done so from a rather detached third person perspective where the student explores a topic with no, or very little, first hand experience with the topic chosen. Incorporating machinima into the methodology of a literature class changes the entire dynamic of the course. First, students must not only select a representative reading assignment that they can experience within Virtual Harlem, but they must also synthesize that topic into a story that can be told and subsequently performed by themselves and others in the class. Second, in addition to performing the text in some meaningful way, the writer/actors must ensure that their performance follows and expands upon their understanding of the written text and vice versa, thus creating a reflexive set of ideas that speak to one another in interesting ways. Thus, performativity is central to understanding the assigned reading. Performance Studies is not, however, new to education.

Most of the scholarly work that I have come across regarding performance studies has been done in theater, music, dance performance or teacher education. Performance studies as a field, according to Henry Bial in his *Introduction to the Performance Studies Reader* suggest that performance studies has the potential to "illuminate, instruct and inspire." I have always believed that in order to engage students in any discipline, they must not only be inspired to read and engage the text but they must know it well enough to be able to discuss and, in some cases, instruct it on a certain level. The experiences that students have in *Second Life* are part of their inspiration/illumination and the machinima they produce is their expression/discussion or "instruction" of that text. Performance is a behavior and if we teach our students to behave in ways that demonstrate understanding of curricular concepts, then one might assume that they are "learning" through performativity. Broadening the idea of performativity into a composition course is in line with the ideas expressed by Richard Schechner in Bial's reader where he suggests that "performing arts curricula need to be broadened to include how performance is used in politics, medicine, religion, popular entertainments, and ordinary face-to-face interactions" and that there is a very complex relationship among the "players in the performance quadrilog – authors, performers, directors, and spectators – [which] ought to be investigated" (Bial 8).

Furthermore, when one considers the power of performativity as it relates to machinima, it is important to consider how the words students write and subsequently translate into a performance can be paralleled with the work of Geoffrey Austin in his most influential work *How to Do Things With Words*. In it, he suggests that words and sentences are not simply truths or falsities used to describe what one is doing but instead performances and or actions actually being done. Using this logic and when paralleling literature with machinima, one may assume that the machinimatic translation of a text is the immediate performance of that which is described in a novel or essay. The immediacy of that production/performance is that which brings the text to life. Performativity through machinima has the potential to completely change how students engage literature that was written decades before they were born. Using this logic along with that of Butler's work, who suggests that we define and understand gender by how we discuss it, thus if we change the way we discuss gender we will in turn change the way we think about it. The same applies to the act of experiencing literature. If students incorporate performativity into their understanding through machinima, it stands to reason that they will think about it differently, thus "doing" literature on a more engaging level.

This essay adds to the growing body of knowledge of how machinima is being used in the Humanities in general and in a literature course more specifically. When incorporated properly in an African American literature course focused on the Harlem Renaissance, machinima has the potential to not only change the way students understand a text through performance but it also helps to create memorable experiences in a class, thus increasing retention. The overall topics included in a majority of the readings assigned for our class include issues related to identity, equality, race, class and gender and it is through machinima that students are offered a creative outlet to express their understanding of these ideas and subsequent experiences in virtual environments. What are good examples of how machinima can be used in an African American literature course being taught in Second life? In what ways does a period-based project like Virtual Harlem, or any themed Sim, enhance the "performativity" of a text? Finally, what is the typical workflow of students participating in a course designed and taught in Second Life that focuses on the literature generated during the Harlem Renaissance?

Course Design and Objectives

Those who know of machinima often consider it a niche genre, relegated to shorts found on YouTube that focus on satirical subject matter, some training or even music videos. Exploring how machinima can help students demonstrate their understanding of a text or concept is a rather recent use of the technology. In the Fall of 2010, I designed and taught a course on African American literature and the Harlem Renaissance where the primary medium of communication, expression and experience was Second Life. The objectives of the course included:

During this term, we will learn, study and use a tool that has changed the landscape of communication, collaboration, journalism and social networking. We will also put to use our newfound skills, reaching out to students in Sweden, France and universities in the US, to discuss "modalities of identity and presence" along with other topics identified by popular and mediated culture. Through the Machinima you create you will exemplify your understanding of complex ideas, and express them in the most creative way possible using this medium.

This rather broad set of objectives was intentional so that students would be encouraged to explore the limits of their learning and use of Machinima while focusing that creativity to express concepts found and discussed in the assigned texts used during the term which included essays, novels, poetry, music and art.

There were 25 students enrolled in the course and a majority of them only had a basic understanding of virtual worlds, a handful considered themselves "gamers" and some had very little computing experience beyond basic Web surfing, watching YouTube videos and checking email. None of them had ever taken an African American literature class. I saw the diversity of this audience a plus, however, because the varying skill sets of the students, I encouraged them to assist one another. Out of the 25 students in class, only 3 had heard of Second Life and only 1 of them had an account (she was a student previously enrolled in a Composition class that I taught in Second Life the semester prior to

this one). The course met one day a week and because of the way our Fall semester began, I did not see them until the second week of classes. They were emailed, however, instructions on how to create a Personal Blog using Blogger, how to create their Second Life account and download the client to their personal computers to test and ensure it works on their machine (those without personal computers were able to use those in a lab/classroom reserved for the semester where Second Life is installed and maintained). They were also instructed to place their real name and avatar name on a Google Document to which they all were given access and editing privileges. These step-by-step instructions were provided both via email and in the Course Syllabus and in the Welcome Email sent to the students. Finally, the students were asked to respond to a VoiceThread, detailing their thoughts and initial reactions to the course situated within the virtual environment of Second Life, Blog creation and the use of Machinima and VoiceThreads (VoiceThread is an audio/video discussion board application where students can respond to prompts made by the instructor using their voices or video) in an African American literature class. Here are a few of their reactions:

“This course is confusing, not sure I will like it very much”

“How cool to have a course in a virtual world! I never thought I would see something like this in college”

“Wow, a course where we can make short videos to go along with our understanding of the readings, cool!”

The first official class meeting was chalked with excitement, anticipation and in some cases, a bit of skepticism. This was all expected. Course Objectives were explained and after some questions on grading and other assignments, we all logged into Second Life. Of course, the organized chaos of that day’s class centered on avatar modification, basic navigation, communication, landmarking, friending, and teleporting. When all of the students were finally in our virtual classroom on Virtual Harlem, we were able to ensure everyone exchanged friendship, landmarked the location (The Dark Tower), and knew the basics of communicating using text (both public and private IM), and voice. Students were told that if they plan to use Second Life at home for our class, that they must have voice communication capability beyond a built-in microphone on a laptop computer, otherwise, they must either purchase an external mic or come to the library for class. This choice of “physicality” for class seemed to intrigue some members of the class.

The class meetings last an hour and fifty minutes and after the first initial exposure/orientation to Second Life, we jumped directly into our course content and activities. Readings were assigned from our first texts and the flow of class included discussing the readings, exploring locations on Virtual Harlem related to those readings and encouraging students to consider how the readings could be expressed through short machinima created in Second Life. These mini-brainstorming sessions were crucial because they helped move students towards a common mode of thought regarding machinima, performance and Second Life. Instead of Second Life being seen as a “game” or 3D social network, students began to consider its usefulness as a creative mode of expression where their understanding of the text could be realized.

Mechanics of Machinima Creation

Because of cost, desires to maintain an initial level of consistency and ease of use, a standard set of tools were introduced to students in order to create their group machinima. Those who were a bit more advanced or who were familiar and comfortable using more complicated tools were encouraged to do so and to show their group members how to use them. However, because some of those tools come at some expense, only free or basic versions of all software used this term were installed on the lab computers and their use taught in class. Machinima involves screen capture, individual and system audio recording and video editing the screen and audio recordings. For screen capture, we used Fraps (which limits captures to 4 minutes for the free version) and Screenr (with a 5 minute limit). The basic difference between the two is that Fraps is a stand-alone application and only runs on Windows based machines. Screenr is a Web-based application that is cross platform (a Twitter account is necessary in order to export screen captures to other formats such as .mov and .mp4). Students were given other options to use such as Jing, Screenflow, iShowU, and QuickTime X, but again, for the sake of consistency, we focused on Fraps and Screenr.

Clean audio is an important part of good machinima and students were required to use external microphones in class and as they recorded their group machinima projects. This, however,

proved to be more of a challenge than initially expected. Those who purchased their own microphones or headsets purchased those of varying quality and as a result, machinima audio was of the same “varying” quality. Some was very rich and full sounding while others were very thin and metallic, like talking in a cave or tunnel. One other unexpected issue with audio was an inconsistent capture of system audio. This is a crucial part of machinima if “live” audio is to be used as part of the screen capture. System audio allows one to record others who are speaking in the same area, ambient sounds and system music. Students who ran into this difficulty, either in Fraps or Screenr worked around the problem by capturing Avatar movements then later recording and adding their audio track during the video editing process. In some cases, this was a much better solution as it brought back more consistent audio quality to the final output.

After initial screen captures were complete and audio was recorded, students were introduced to an online non-linear video-editing program called JayCut. This Web-based non-linear video-editing program offered the most useful, elegant cross platform solution for students to learn. It is also free, which was a plus. After students captured their video, which contained good audio, or they recorded their audio outside of Second Life, they then were shown how to import their content into JayCut. This program allows for one video track and up to four additional audio tracks. According to the JayCut Site, the advantages of using an Online Video Editor include:

- No need for downloads or installs
- Instant access via any web browser
- No specific hardware requirements
- Access uploaded content anywhere, anytime
- Works on all computers and browsers
- Use content on the web in movies, e.g. YouTube videos
- Collaborative editing, work together with other users from around the world.

Given these tools, students were now ready to begin their Group Machinima Projects. They were required to create at least one individual practice machinima to acclimate themselves to the screen-capture, audio recording and video-editing process, and one group machinima practice. We “peer critiqued” these projects in Second Life using HTML on a prim after these videos were uploaded to YouTube, offering suggestions for improved audio and video as well as camera movements.

For the individual practice machinima, the students served as directors, actors and camera operators for their own videos. This way they could learn how to perform each of these roles with some level of competence. The group machinima practice videos allowed for some level of flexibility in the roles students assumed. Some were much more comfortable serving as camera operators as they were either very good at it or in two cases, had external joysticks which allowed for more smooth camera operation than that which is possible with a mouse or keyboard. Those students who were more comfortable writing served as initial scriptwriters and subsequently directors and the others assumed acting roles. These self-assigning roles occurred rather easily as students became more comfortable navigating the environment.

Group Machinima Projects

The Group Machinima Projects were a central part of the course requirements in the class. Students signed up for a collaborative group on Google Docs. Each group consisted of 3-4 members of the class. Requirements for this assignment were:

This project requires that you work with a small group of your classmates (your choosing) that consists of at least 2 other members of our class. (If you work with students from one of our partner institutions you will earn extra credit. This includes students from France, Sweden, or a university in the States). Your project must focus on a topic/theme of your group’s choosing yet found in one of our course texts. Suggested topics include but are not limited to:

Identity
Presence
Acceptance
Material Culture
Defining Friendship and Trust

Equality, Race, Class or Gender

Once recorded and edited, this assignment was to be posted on a video sharing site like YouTube, Blip.tv or some other video sharing/streaming site (there are several available from which students could choose), and it should be at least 3-5 minutes long. It should include meaningful dialogue with your group members or at least meaningful participation by all members. The topic of each group machinima was to be posted on students Personal Blogs, and scripts should be posted on Google Docs, accessible by your group members and me (instructions were offered in class to those not familiar with Google Docs). The link to the Small Group Project were to be posted on our Small Group Sign-up Google Document in the appropriate area and embedded on the Personal Blogs of all group members.

These were quite hefty requirements for students just learning Second Life, some with little or no experience with machinima, video editing or advanced computing. In order to make efficient use of our time in class as well as to provide ample time in class to film, edit and receive instruction and feedback from me on the use of these tools, our class incorporated a rather unique workflow throughout the semester.

Our class focused on a variety of works written by prominent writers and scholars of the Harlem Renaissance, artists of the period and entertainers. Weekly readings were assigned and students were required to post VoiceThread responses to prompts that I gave them. Their responses had to be either audio or video so that students could become more comfortable using their voices to express their ideas related the Harlem Renaissance with support from the texts. All of our class sessions after the second week of school were held in Second Life. By this time, students were minimally comfortable with voice communication in Second Life and we experienced very little if any audio issues throughout the term.

During our class sessions, we initially met on Virtual Harlem, one of the islands I own in Second Life. Our classroom there is rather traditional with two rows of seats, two screens at the front of the room capable of presenting images (slideshow presentations) and Web Pages, (for rich Web media on a prim). At the beginning of class, I gave announcements, answered any questions that students asked about the reading, some technical aspect of one of the tools we used, or shared some experience they had in Second Life. I always encouraged a light and conversational atmosphere in class so that students would liken their Second Life experience with that which goes on in a more traditional classroom, *on steroids*. The enhanced aspect of Second Life allowed very unique experiences in just the first part of our class, even before we worked on machinima projects. Several times, when students shared some interesting place they visited in Second Life, I asked him or her to share the landmark in a teleporter I had set up in the classroom and we all simply went there, with the student serving as a field trip leader so to speak. These impromptu excursions served to not only broaden the student's view of Second Life but also encouraged students to be one of those leading the trip for the next class.

The next part of class was spent briefly discussing the day's reading assignment. We began listening to one or more VoiceThreads and commenting on the ideas that the student(s) expressed and how that related to the reading. Students offered feedback and ideas of their own based on what they saw or heard from the VoiceThreads played in class. These were all played on the screen in our classroom in Second Life. This part of class was also used to bring in guest speakers who were experts in machinima and who and who answered student questions while showing examples of their work.

The lions-share of class was spent with student groups working on their machinima projects. Students disbursed to the various locations in Second Life where their video shots were taking place for that class period (I say that period because their videos were shot over a period of several class periods at a variety of locations). As students were shooting, planning video shots or practicing their machinima, I traveled to each group location and observed, answered questions, and or offered suggestions. Usually, groups had at least an hour or more during each class to shoot their video footage. Students were instructed to shoot several shots/angles of the same dialogue or scene so that they can then mix/edit that raw footage into their final video. This process continued for the next 8 class periods (approximately 2 months). Students were also encouraged to meet outside of class in Second Life to work on their projects, shooting video, practicing dialogue, scouting video shots or filming technique and camera movements.

After video footage was captured and audio was recorded, students were taught how to use the online video-editing program, JayCut. This program is great because students can log on at the same time and chat while editing their video. Some used Skype to communicate instead and others used traditional instant messaging. One group chose to meet in a small media preview room in the library to edit their video as a group, face-to-face. After meeting initially in Second Life, students would then move to JayCut to edit their video footage. During these meetings/editing sessions held during class, again, I would drop in and offer suggestions, comment and answer questions using whatever communication method the group was using. This schedule was maintained for several class periods, using a majority of the class for this editing process. The peer teaching and learning that took place during these sessions was phenomenal. At the end of the term, students expressed an overall increase in their technical skills as well as an acquisition of skills that they felt they would use outside our class as they moved into their careers. These complimented a new-found interest in African American literature to which none had previously been exposed. Links to a few of these machinima video projects are here: <http://www.youtube.com/watch?v=QrZv7lJU20k&feature=g-upl> , here, <http://www.youtube.com/watch?v=z9tjkl-5Q&feature=g-upl> .

It was near the end of the semester when several of the students began to make very interesting connections between what they were experiencing and that which they were filming and about which they were reading. Although they did not have the language to express their observations, several commented that they could now show, through their machinima, what they were trying to say in their essays, or that when I asked for further explanation about something written, the response was, “here let me show you what I mean. They were unconsciously doing exactly what Austin suggested was possible through words, that instead of words simply describing the world and associated experiences that one has within it, they were performing their experiences and associated readings through the machinima projects they created. Instead of simply writing about something they just read and discussed in class, they were able to include what the experience was like visiting a location that was similar to that which was depicted in the text, they performed it by taking the viewer there and going through the experience

I must say that overall, the machinima projects in this class were a success. Not only did students demonstrate creative ways to express their understanding of concepts found in the reading assignments and discussions related to African American literature, but they also learned new skills. However, the semester was not without some problems. The most significant problems occurred when there were issues with Second Life. Unexpected updates, voice communication issues or lag related mostly to bandwidth at our university or with a group member’s Internet service provider were sometimes a challenge. Bandwidth also proved to be a problem at times when students were editing their videos on JayCut. One student would make a change but it would not appear for a few moments, causing another student to make a different change and when the original change appeared, it caused some confusion. Audio consistency was also a challenge. Students with inferior mics or headsets were not able to clean that audio well enough to match that of those with better audio input devices. The difference was quite evident in some cases. Finally, and most surprising to me, some students had a difficult time being creative in their machinima projects. Initially, there were a few groups that designed “presentation-like” machinima; those where students were basically standing in a park or other location taking turn reading dialogue. It took several class periods, countless examples and quite a bit of prodding to encourage more natural dialogue, creative camera shots, scene changes and overall creativity before students understood what I was looking for. As much as we would like to believe students of this generation exude creativity and or are technologically adept, I found this to not always be the case in this class with this group of students.

Machinima is one of the most creative ways in which students can express their understanding of complex ideas while learning new skills, all within an environment that encourages interactivity and engagement. The activities, requirements, organization and flow of our African American literature course are only one example of how Machinima can be effectively used in a course like this. Success hinges on not only good organization but also consistent technology and equipment. Most importantly, faculty teaching a class like this must be comfortable and familiar with all aspects of the programs being used. Any hesitancy or confusion on the part of the instructor will transfer to the students, which, in my opinion, will create a tense learning environment. If, however the faculty member is knowledgeable in not only the tools but also teaching pedagogy and methodology in a virtual environment, the environment in the class will be lively, communicative and interactive.

Virtual Harlem: An Evolving Present

In 2004, the University of Paris IV-Sorbonne funded the development of Virtual Montmartre. This project realized itself in the development of an interactive Web Site and a small 3D recreation of the Lapin Agile, the oldest surviving cabaret in Montmartre, which is still in operation. The relationship to Virtual Harlem is clear to scholars of the Jazz Age/Harlem Renaissance, for it was in this Arrondissement in Paris, the 18th, that Jazz was introduced and popularized in Europe by African American troops who fought under the French flag in World War I. The National Black Programming Consortium and the Government of Norway, through the enhancement of Virtual Harlem and Virtual Montmartre in Second Life, funded the evolution of Virtual Harlem in 2006. In Second Life, The Virtual Harlem Project (now a combination of Virtual Harlem and Virtual Montmartre) has blossomed. It is the oldest environment in Second Life focused on African American culture and certainly one of the few surviving areas where literature, history and culture are taught. Through collaborations with academics, students, residents of Second Life, entertainers and artists, The Virtual Harlem Project has taken on new life. There are currently a variety of projects ongoing such as the development of an interactive game, a very active artist community with real-life artists displaying their work and conducting exhibits and presentations, jazz artists conducting live concerts, students actively working on course projects like museums and artists appreciation exhibits, tours and discussions. We are even exploring the use of Automated Agents portraying historic figures as a way to incorporate interactivity and offer information about the period. As exciting as Second Life is for teaching and learning, it appears that interest is declining among educators as a result of outdated technology; graphics not keeping pace with current gaming engines and most importantly, cost.



Figure 2.

In 2010, Linden Lab announced that they were doing away with the educational discount for regions and full islands in Second Life. This effectively doubled the cost for educators and non-profits that were using the platform. This price increase, to some, was the last nail in the coffin for a platform that some believed had seen its best days. Technology evolves very quickly and is particularly fluid when it comes to gaming and graphics. Unfortunately, Linden Lab failed to keep up with modern gaming platforms because their outdated codebase could not easily be modified to incorporate the increased graphic capabilities of modern computers. Because the environment renders in “real-time” it was also difficult for the platform to compete with console games whose graphics were pre-rendered and with which the current generation of student-gamers was most familiar. As the graphic quality of console games continued to improve, the differences between those platforms and Second Life were increasingly apparent. Ownership of virtual property also became an increasing concern for many

educators and non-profits. Most universities and government funding agencies even began refusing to fund projects making use of the platform, in part, because of ownership issues and the proprietary nature of the platform itself. Finally, the Second Life viewer became increasingly unstable and was plagued with constant updates, making it very difficult for lab-based classrooms to keep up with the changes. Students do not, in most cases, have administrator rights on school computers, so it was up to lab administrators to update the machines when updates were needed. As a result of these issues and a host of internal changes in Linden Lab regarding their business model, many educators began searching for alternative platforms that were open source, with similar functionality, cross-platform capability, and that were low cost.

Virtual Harlem: An Exciting Future

Creating a long-term road map for Virtual Harlem has been an imperative for the past few years. I am well aware of the limitations of Second Life and to some extent most of the alternatives. The commitment to using virtual worlds in education, however, remains an important part of my research, therefore, until the technology catches up with ideas that I have, incremental steps are necessary towards a much more exciting future for the project.

One of the more exciting developments that have emerged as a result of the impact made by Second Life is the Open Sim initiative. According to the Open Simulator Web Site, Open Sim is a platform for operating a virtual world, and supports multiple independent regions connecting to a single centralized grid. This is somewhat similar to the web, where anyone can run his or her own web server, tied together through the Internet. It can also be used to create a private grid, analogous to a private intranet. This open sourced version of Second Life is exciting because many of the limitations inherent in the SL platform are not present in Open Sim. For instance, limitations on the number of objects on a region, number of simultaneous visitors, and cost are all rather fluid and can be adjusted by the Open Sim administrator. Of course, any adjustments need to be balanced with available bandwidth to the server, available databases, the size and complexity of the build and the strength of the server.

Because it is so much less expensive to use Open Sim rather than Second Life, and because the platform is open source, a logical step for the Virtual Harlem project is to move to Open Sim. This decision, however, does not come without some reflection. First, and most concerning, is that the Virtual Harlem project must be rebuilt. This is because of two reasons. The permissions and ownership mechanism in Second Life was created to protect the creators of various objects, which was a good thing. However, because of this, when residents purchased or freely obtained objects used in builds, those permissions usually remained limited. In order to move anything from Second Life to another platform, one must have full permissions and ownership of the complete object, which includes textures, scripts and the primitives. Unless these permissions and ownership were granted when the object was obtained, it is very difficult to change retroactively. Secondly, moving to Open Sim caused me to pause because there is not quite the community present as there is in Second Life. This community of Second Life residents is made up of individuals from all walks of life that gravitate towards groups or regions of particular interests. In the case of Virtual Harlem, practicing artists, entertainers, poets, educators and those interested in the period make up this community. Currently, Open Sim lacks this feel and it will be sorely missed when the move to Open Sim takes place. These are the two most concerning aspects when considering the move from Second Life to Open Sim and they will be costly in a variety of ways. There are, however, very compelling factors that not only encourage this move but also suggest that moving from Second Life is the only way that Virtual Harlem can move forward.

Preparing Virtual Harlem for the future that is envisioned necessitates a total restructure of the build. This rebuilding process involves converting/rebuilding all of the current structures into a standardized output format. In addition to this, we have learned that it is crucial to establish a uniform system of object ownership and permissions so that if and when objects are exported, they are done so intact. "Mesh" is the current object construction standard for modern gaming environments. When objects are created in 3D modeling applications like Sketch-up, 3D Studio Max, Maya or others, one of the many output formats is Mesh. Once the entire environment is reconstructed using mesh there are plans to more accurately represent the location of landmark locations. Because we will have much more virtual real estate in an Open Simulator environment, incorporating accurate topographical and terrain information is also part of the plan. This will allow us to collaborate with faculty members in those

disciplinary areas, focusing their efforts on that which is specific to their field. Global Information Systems data can also be incorporated onto selected locations so that the idea of data mining can be experienced on an entirely new level; one that encourages exploration and contextualization while searching for relevant data. The long-term plan for the Virtual Harlem Project is to use Open Simulator as a development, research and collaborative platform where experimental techniques can be evaluated, new content can be added and where teaching and collaboration can occur.

Over the next 2 years, we plan to evaluate several runtime platforms and gaming engines that will accept exports from Open Simulator. The idea is to select one or two of the best in terms of graphic quality, interactivity, cross platform capability and multi-player capability. When content is added and vetted in Open Simulator, the plan is to render it in one of the selected game engine platforms and make that export freely available. This will allow for higher graphic capability, advanced interactivity and perhaps increased interest in the project by a generation of learners who may be more familiar and accepting of virtual environments that more closely parallel modern video games in terms of graphics and interactivity.

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Figure 1: Virtual Harlem The Cotton Club

Figure 2: Virtual Montmartre Zelli's Cabaret and The Moulin Rouge

A Show-Me-By-Example Approach to Teaching Programming the Internet-of-Things in Immersive Education

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Abstract

In this paper we address the issue of how students can learn computer programming using a more natural approach that takes inspiration from an intuitive way people learn and of accomplish tasks (by example), a technical implementation of that approach (programming-by-example) and an immersive educational environment (the eDesk) that combine to provide a novel and accessible approach for students wishing to learn the fundamentals of computer programming.

1.0 Introduction

Learning to read and write programs is a fundamental skill in computing. However, many students struggle to master the basics involved. New networked based technologies, such as the Internet-of-Things are particularly challenging as they are effectively distributed computing systems. The graphical nature of immersive educational environments offers an opportunity to approach learning this type of computer programming in a fundamentally different way. There has been some previous work on developing graphical programming tools that capture spacial and temporal relationships and ease the process of learning to program. For example MIT's Scratch is a well-known teaching tool that captures the essence of "programming" in a way that simplifies the learning process and allows users, in particular young people or children, to creatively construct their own programmed animated sequences via a graphical interface while at the same time, learning the important concepts of programming but without needing them to write any programming code [Malony 2004]. Likewise, Carnegie Mellon's Alice, aims at creating a 3-D programming environment for its users to learn fundamental programming concepts by creating "programs" that interact with the 3-D virtual environment [Kellecher 2006]. In this paper we look at another novel approach to programming called Pervasive Interactive Programming (PiP) that was originally developed for programming intelligent environments, such as smart homes. PiP is part of a larger programming family that is more generically

referred to as “Programming-by-example”, which was introduced by Smith in the mid-seventies, and is based on the principle that required computational functions are converted to executable code through the user demonstrating required behaviour rather than trying to specify it using various abstractions, such as programming languages [Smith77]. PiP differs to Scratch and Alice in that it targets distributed computer systems, such as the Internet-of-Things.



Figure 1 – Advertisement of ePod from “Tales from a Pod”

2.0 The Immersive Learning Environment – the eDesk

In the paper “*Tales From A Pod*” we described a futuristic student-learning environment called the educational-pod (ePod) [Callaghan 2010]. In Callaghan’s paper, the ePod was described as a small immersive reality cocoon (see figure 1) in which individual students entered to find themselves in a graphically based interactive environment that feigned a real classroom.



Figure 2 – Practical Realisation of the ePod, the eDesk

The environment featured numerous high-tech functions including intelligent tutors in the form of avatars that provided teaching and learning services to the student. Later, a UK company specializing in the manufacture of virtual reality

environments, Immersive Displays Ltd¹, took this vision and translated it into a practical unit, the ImmersaStation², which is the host immersive-learning environment of the work presented in this paper, see figure 2. The concept of the ePod features in two other projects, the Shanghai Jiao Tong Network Education College work on embodying their intelligent student answer machine as an Avatar [Zhang 2011] and Jeddha's King Abduaziz University ScaleUp work on immersive-mixed reality learning [Pena-Rios 2012]. The ImmersaStation runs a virtual classroom called MiRTLE (Mixed Reality Teaching and Learning Environment) [Gardner 2010], which provides a virtual classroom in which lessons are situated (shown in the screen of figure 2). This then forms the immersive learning environment that our novel approach to teaching computer programming targets.

3.0 The Internet-of-Things

Computer networks are becoming ever more pervasive resulting in a world where almost every *“thing”* can be connected to the Internet; the so-called *“Internet-of-Things”* (IoT). In this connected world the balance between the real and virtual is altered, with our daily interactions being split between the physical and electronic domains. For example, the Internet can be embedded into things ranging from bathroom scales through cookers to cars. There are no reliable estimates for the size of this market but a report by the “Arthur D. Little management consultancy” suggests that by 2020 the IoT market could be worth between 22 billion and 50 billion dollars [Schlautmann et al 2011] made up of some 16 billion connected devices [Vermesan & Friess 2011]. This rising demand for Internet-ready *“things”* is good news for graduates as there will be increasing job opportunities for them. However, this new technology demands the acquisition of difficult skills such as programming distributed embedded-computers that, in turn, raise the challenge to educators as to how best to teach these skills. In this paper we present one potential solution to this challenge; Pervasive interactive Programming that we will introduce in the following section.

4.0 Pervasive Interactive Programming

End-User programming is characterised by the use of techniques that allow the end users of an application to create “programs” themselves, without needing to write any code [Cypher et al]. A common way to achieve this goal is to create propriety types of “scripting languages”, abstracting conventional programming algorithms into some form of representations (eg graphical objects) and then provide a platform for the users to manipulate these representations as the basis of learning how to create a program. Most, if not all of existing work on end-user programming targets the development of programs for a single centralised machine, creating programs by manipulating abstract graphical objects.

¹ <http://www.immersivedisplay.co.uk/>

² <http://www.immersivedisplay.co.uk/immersastation.php>

Pervasive-interactive-Programming (PiP) however is aimed at programming distributed computers, embedded into real physical appliances, such as those that make up the Internet-of-Things, which was described earlier. The concept underlying PiP is simple in that it mimics the traditional ‘playful’ method that has been used to teach children for generations – the teacher demonstrates an action by showing an example; the learner then repeats the demonstrated action.

In PiP, the ‘things’ that comprise the programming environment are categorised into 2 types: (a) physical ‘things’ (including graphical representations of them) which we call “hard things”, (b) abstract things (eg application software such as email, instant messaging etc.) which we call “soft things”. Both types of ‘thing’ provide their functionalities in a form of services that are network discoverable and accessible.

The availability of numerous networked ‘things’ and their services present an opportunity to group them together to provide meta-services or meta-appliances. In PiP we called this the “deconstructed appliance or application model” which can be regarded as a form of virtual application / appliance [Chin et al 2006]. The representation (specification) of such virtual entities is referred to as a MAp (Meta-Appliance/Application). It contains detailed information about the community of “things” and rules that govern their functionalities. Rules are created by the end user as part of programming the system.

In our immersive education environment the student is presented with a stimulation of the lab environment that they use to show an example of the required functionality to (which the system encodes as a set of rules). This is also what we sometimes called “*natural programming*”. The user is then able to “play” the program and watch the animation to be sure it works as they intended. In this way PiP encourages user interaction as a way that helps the student visualise the programming concepts. In this way PiP acts as a computer programming learning tool, which uses a graphical interface that sits on a virtual reality environment.

5.0 Pervasive Interactive Programming as a Teaching Tool

The inspiration for using Pervasive-interactive-Programming to teach students how to program computers arose from two perspectives. First was the observation that much of the learning in early childhood arises from replicating examples of behaviour that people observe in each other [Brown 2008] and secondly, that at the heart of pervasive interactive programme (a methodology based learning-by-example) are IF-Then-Else rules, that are the core construct of procedural programming languages [Chin et al 2006]. Thus, by providing a mechanism to translate behaviour examples into rules, we have a natural and intuitive model of procedural programming. In the following sections, we explain in more detail the reasoning behind this approach.

5.1 People as a program emulation

An approach that has been adopted by some teachers introducing students to programming, is to mimic the workings of a computational machine by using students to act as the various components in a processors [Kacmarcik 2010]. Thus, for example, a number of students might act as instruction stores, another might be a program counter, another might be an instruction fetch unit, another might be an arithmetic execution unit etc. Then by acting out the sequence of fetching and execution of instructions, students have a visual physical example of how a computer functions. There is something very intuitive in demonstrating or observing physical analogies of abstract processes; a feature that we have tried to capture in our use of PiP as a teaching tool, as the next section will explain.

5.2 PiP as a program emulation

The basic principle of Pervasive Interactive Programming is to capture the macro behaviour of a system as a series of micro tasks, by the user demonstrating to the system examples of the required functionality. PiP captures and describes these micro tasks by means of rules. Sets of these rules are then are combined to form the macro level behaviour of the system. In PiP, rules are normally internalised by the system, and are not usually visible to the user. However, for using PiP as a teaching tool, making the rules visible becomes an important aspect of the pedagogical process. This is important because the core construct of both PiP behaviours and procedural programs are rules. This is illustrated in Figure 3. Rules enable decision-making and decision-making is a key property for any entity that purports to be smart. Its contribution to making Von-Neumann style computers the powerful and flexible problems solving machines we are familiar with, is hugely attributable to there being a decision making mechanism embedded into its structure.

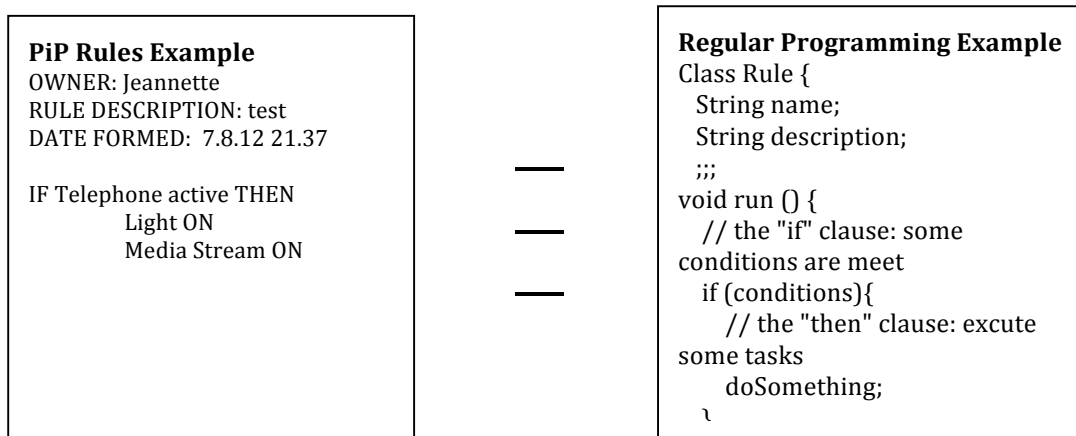


Figure 3 - Equivalence between PiP and Programming decision constructs

It would be hard to exaggerate the importance of decision-making functionality in computation. Without the ability to make decisions computers would be relegated to machines that stepped unidirectionally through lists of instructions. Computers would still be programmed, in the sense someone wrote out those lists of instructions, but the ability of a computer to restructure its computational

strategy and adapt to new problems or contexts would be severely (perhaps fatally) restricted. The use of a decision making structures comes at a large cost; understanding, designing and handling the numerous combinations of resulting program control flows, which has the potential to become a task of daunting complexity. In fact, this is such a big issue it is one of the key targets of software engineering [Callaghan 1982]. Thus for students learning programming a key and complex, aspect is to understand the nature of decision constructs (their relationship to sense-action pairs from data and physical domains), how such decision constructs are formed and how they contribute to the functionality of the overall program. Our approach is to focus on exposing and understanding the role of rule formation as the key construct in computer programming. We do this by employing PiP to show the linkage between sense-action pairs in the real world, and the creation of corresponding rules in the computational machine. We then link these rules to the if-then-else programming constructs in procedural programming languages, which we then use as the launch-pad for students entering and following the more traditional route to learning to program. In this sense our technique is to provide an intuitive and interactive (constructionist) pedagogy for introducing programming concepts to students who are not, initially, technically literate.

5.3A distributed computing programming example

To illustrate the principle of how we use PiP as a tool for teaching computer programming, we will first present a scenario that involves programming a community of ‘things’ to provide some coordinated functionality. In this example there are three main components being controlled; a telephone, light and media player. The basic idea is that the system should be programmed to provide the behaviour such that when an incoming call arrives, the lights would raise and the media player would stop. Figure 4 – 6 illustrates PiP in use. In a typical teaching session, before logging the system the student is provided with examples of regular programs (eg C and Java) that have the important constructs such as rules, highlighted. At this point they are not expected to understand the program, just to appreciate the main elements. The students are also shown simple examples of programmed coordinated activity (eg a media player coordinating actions with a light). The student is asked to write down the behaviour of the system they wish to create, as a simple state-action list. The student then logs into the system and begin to translate the specification they written into “programs” using PiP interface – via steps (1) exploring things (2) selecting things by dragging and dropping them into the ‘programming area’ via the graphical interface control panel. In the second phase the student then demonstrates the actions (ie the specified behaviour), which PiP translates into a set of rules, see figure 5. Once the student finishes their “programming exercises” they will able to see the program descriptions in the form of plain text (showing the sense-actions) or actual programming code (the PiP translation comprising rules). The student is then encouraged to replay the program to verify the intended behaviour occurs (ie that the specification is met) before saving their program, see Figure 6. In the third phase the student is invited to look at the constructed rules and relate them to the actions. It is then explained to the

student that a simple procedural language uses these rules as the core decision construct.



Figure 4 - a) User log in screen b) select 'things' by dragging to composing area

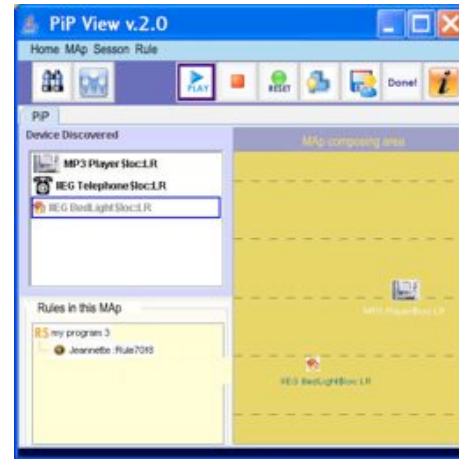


Figure 5 - a) constructing rule b) rule formed (Jeannette_Rule708)

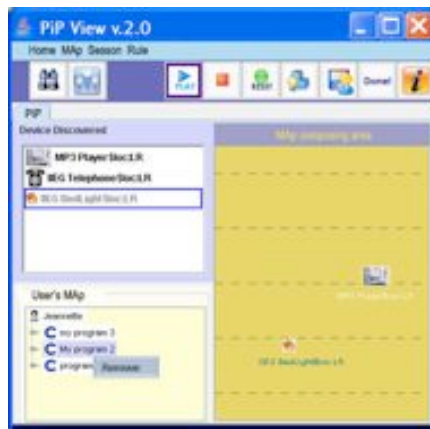


Figure 6 - a) deleting MMaps (rules) b) saving MMaps (rules)

The student is then invited to re-execute the program to verify it's action before being invited to alter the rules manually via the interface, without going through the demonstration cycle again, to make the environment achieve a modified behaviour. The student is then shown how such rules can be translated into actual programming code (by the addition of supporting code such as declarations and operators). Finally, students are then encouraged to compare the manual and automatically generated code to deepen their understanding. Thus, this forms the basic introduction to programming and the task may be progressively made more complex to increase the confidence and programming skills of the student. In our prototype (figures 4-6) we are still experimenting with a 2D view but our next step is to take better advantage of the 3D view that our MiRTLE immersive application facilitates to provide a better immersive experience.

6.0 Summary

In this paper we have introduced a novel end-user programming environment called Pervasive-interactive-Programming (PiP) which we contend offers a particularly intuitive and simple way to introduce new students, or those not majoring in computer science, to programming. The tool goes beyond existing teaching tools, such as Scratch, in that it introduces students to the basics of distributed programming, an intrinsic feature of the newer computing paradigms such as the Internet-of-Things, Pervasive Computing and Intelligent environments etc. We advocate this methodology for immersive education, as it is inherently compatible with the graphical nature of immersive environments. Concerning future directions for our work, there are many possibilities. Our current trials of the system have concerned only small numbers of people, which have allowed us to prove the concept, but we like to expand and formalise this. Also, although we have not exploited this in our current work, the ability of immersive reality environments to materialise abstract programming concepts, such as data structures, semaphores etc offers much potential for the development of the tool in a way that capitalises more fully on the immersive reality nature of the environment we have created. Apart from moving from our current 2D (proof of concept) to a 3D representation, another area we would like to advance our work is to move from what is essentially a single user system to a co-creative team based programming environment. Thus there remain many opportunities for our research to develop which we hope to be able to report in later papers.

Acknowledgement:

We are pleased to acknowledge our colleague Anasol Pena-Rios whose work on end-user programming applications for mixed- reality learning which both motivates and complements this research.

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Views of Educators on Immersion in Virtual Worlds from Second Life to OpenSim

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Abstract. Whilst until recently Second Life was the most popular and widely used virtual world, the OpenSimulator (OpenSim), a new technology for the implementation of virtual worlds, has the potential to replace Second Life, given its similarity with the underlying technology. In this study we investigate and compare the immersion developed within Second Life and OpenSim based applications taking into account the different ways with which the OpenSim implementation is attained by the educators (hosted by the institution / externally). In doing so, 34 structured interviews have been conducted with university educators who expressed their opinion regarding the conditions under which immersion can be further enhanced. The results of this study demonstrate a clear trend and reveal that the orientation process, the educational activities that take place within the context of a virtual world, the technical issues that may downgrade them, the students themselves, and the network of interactions that occur in-world, affect the level of immersion encountered when used for educational purposes. Second Life meets these conditions best, but that does not mean that the OpenSim worlds are not or cannot become immersive and that they do not or cannot engage students with the educational activities.

Keywords. Virtual world, Second Life, OpenSim, immersion, immersive learning, educational activities, effectiveness, attractiveness, experientiality, pleasure.

Introduction

While some years ago there was a ‘hype’ in the use of Second Life as a virtual environment, the virtual world community has since then entered a certain phase of disillusionment concerning this particular provider [1], while more and more educators seek for alternative solutions. Indeed, immersion is an essential factor for achieving satisfactory learning results within the context of a virtual world, as indicated by several scholars [e.g. 2, 3 & 4], and thus it is advisable that educators do not disregard it when they are faced with the decision to use a virtual world for educational purposes. On top of that, in [2, 3 & 5] it is emphasised that immersion is an intrinsic feature of no virtual world, whilst in [6] very different levels of immersion are identified in five different virtual worlds.

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Motivated by the empirical speculations presented in [6], this paper aims mainly to clarify the factors that affect immersion, and provide clear guidance to educators who are faced with the decision to use in their teaching Second Life or OpenSim worlds, hosted either institutionally or externally, aiming to provide their students with immersive learning experiences.

For the collection of as much and as detailed information as possible, the direct record of the educators' views through interviews was considered appropriate.

1. Immersion Overview

A comprehensive literature review on immersion has been given in [7]. This section is therefore largely based on [7], however tailored to the needs and aims of our investigation. According to Onyesolu [5], under certain circumstances virtual worlds have the potential to become immersive and engaging. Bredl et al. [2] agree with [5] and note that, inside the virtual worlds, users are able to feel immersed, develop the sense of being part of the virtual world, and that they interact directly with the virtual context of the world. In [8] immersion is defined as the users' sense of belonging in a virtual world. In [2] Bredl et al. indicate that immersion occurs when, in a given period of time, users interact more with the context of a virtual world than with the real world. Similarly, in [9] immersion is defined as the phenomenon during which "one has left the real world and is now 'present' in the virtual environment" or, more simply, a phenomenon during which the users of a virtual world focus their senses on stimuli received from the virtual world and completely or partially ignore the stimuli received from the real world.

1.1. Factors

Childs [3] seems to agree with both Onyesolu [5] and Bredl et al. [2] on the fact that immersion is not an intrinsic feature of virtual worlds, but only one potential characteristic of them. He notes that some users never experience immersion in the virtual worlds, others evolve into partially immersed ones, while others get to the point of feeling absolute presence in a virtual world. Nevertheless, he stresses that just using a virtual world is not enough for immersion to be achieved; a number of conditions is essential to be met.

In the relevant bibliography [2, 3], four factors that influence whether and to what extent users of virtual worlds will experience immersion were identified. These were:

- a. Users' willingness to be engaged and immersed
- b. The use of avatars
- c. The coexistence of users and their interaction with others in the context of virtual worlds
- d. The technical characteristics and the context of the virtual worlds.

Childs [3] and Bredl et al. [2] rank users' willingness and ability to become part of a virtual world, to be immersed and engaged, among the top factors influencing immersion. Childs [3] emphasises that, regardless of the characteristics of a world, its plausibility, its vividness, and its interactivity, whether and to what extent users will experience immersion within its context depends on them, since all the features mentioned cannot be assessed completely objectively. Instead, users judge virtual worlds subjectively, from their perspective, according to their own needs and

influenced by their own unique psychological and mental processes, which ultimately are the ones that lead them or not to a certain level of immersion within the virtual world.

The use of avatars in virtual worlds like Second Life and OpenSim, has a positive effect on the users' development of the sense of presence, according to researchers' opinion. This view is supported by Bredl et al. [2] who, in fact, emphasise the positive impact that the use of avatars has on educational processes. Meanwhile, De Freitas et al. [10] refer specifically to the sense of presence users develop because of the opportunity they have to directly handle their avatars and, through them, the content of the virtual worlds. Levesque & Lelievre [11] add that, through the use of avatars, users distance themselves from what is taking place in the virtual world and believe that the avatars, and not themselves, are the ones that act in the world. It is this conviction that results in increased levels of immersion on the part of the users. Kay Michel et al. [12], from their point of view, refer not only to the use of avatars, but especially to the use of avatars that users themselves have altered and shaped according to their individual taste and choices, as an important element that affects their immersion.

Some scholars proceed the formulation of their conclusions one step further and note the effect of the sense of co-presence on the development of the sense of presence. Vosinakis et al. [13] highlight the importance of users' coexistence in a "shared space" and stress that this plays a decisive role in the engagement of users in-world. Bredl et al. [2] emphasise that the coexistence with others in the virtual world is more efficient than the individual and independent existence of avatars, in causing immersion to develop. Thereby, an additional factor which concerns the network of interactions occurring among users is raised. Annetta et al. [9] indicate characteristically that a virtual environment "exists" when there are users in it, interacting with its content and with each other; respectively, a user "exists" in a virtual environment when interacting with other users and the world. At this point, based on what Annetta et al. [9] stated, the following reflection shall be expressed parenthetically: to what extent is this sense of immersion and actual sense of presence likely to be cultivated within the context of a private hosted server, like those that may be developed through the use of OpenSim technology?

Childs [3] notes that the activation of this sense of presence and co-presence is greatly hindered when users find it difficult to manipulate the context of the virtual environment and the technology of the virtual world. Of course, the vividness and the plausibility of a virtual world contribute positively to the users' engagement in the world, as reported by Bredl et al. [2]. Even though Childs [3] does not disagree with this view, he regards the users' willingness to be immersed in the world as a more important factor in achieving their engagement. When a virtual world is to be used for educational purposes, decent time is essential to be devoted to the students' familiarization with the world in order to enable them to form their avatar –and by extension their virtual identity– and also learn to interact fundamentally with the virtual environment, as reported by Childs [3] and De Freitas et al. [10]. Additionally, De Freitas et al. [10] note that the realization of these procedures, which on the whole they call "orientation", requires that specific actions be undertaken under the supervision and assistance of the educator in charge in favour of students. Finally, Childs [3] notes that the technological problems and the utilitarian issues which characterise virtual worlds like Second Life, are like obstacles to the users' path towards immersion.

1.2. Necessity

Through the research they conducted, Bredl et al. [2] concluded that when students are immersed in a virtual world, they have increased motivation for learning through this world, while they are more likely to be engaged in educational activities. Childs [3] on the other hand, finds a positive correlation between the development of the sense of presence and the satisfaction felt by students during the execution of an educational activity in-world. Combining this statement with what was mentioned above, it can be deduced that immersion in the virtual world is necessary if educational activities are to be found as really pleasant for students.

Despite the fact that the topic of immersion in virtual worlds in general has been investigated extensively and in detail, literature search revealed that there are only few studies focusing their interest on the immersion that develops in particular within the worlds of Second Life and OpenSim. Furthermore, no research was detected directly comparing the two worlds as to their ability to provide their users with a sense of presence. Kostarikas et al. [4] carried out a research on the educational use of Second Life and realized that the students under observation developed a sense of presence within the world: they got immersed and did not hesitate to co-operate in-world with their –unknown until then– fellow students. The same research also suggests that lack of familiarity with the world of Second Life causes insecurity to new users and acts as a barrier to the students' way towards immersion. Nonetheless, all the students who participated in this research were satisfied with their learning experience within Second Life and were also positive to the idea of using it again in the future [4], thereby indicating that eventually they did experience immersion inside the virtual world.

Hockey et al. [14] emphasise that the advantages that Second Life –as an immersive virtual environment– has, are not found exclusively in this world. On the contrary, immersion is a feature of any virtual world that provides opportunities for direct visual contact with the subject taught and interaction with the environment and other users. This view can lead us to the conclusion that such immersive experiences may be provided by OpenSim as well, since it shares many common features with Second Life concerning its context and function. Ridgewell et al. [15] report that the OpenSim technology creates an environment which may accommodate engaging and playful educational activities that lead to the immersion of students into the world. Zhao et al. [16] also suggest the use of OpenSim technology for the creation of immersive virtual environments, which are characterised by plausibility, interactivity and ability to engage students.

However, Childs [3] argues that the number of simultaneously logged-in users in a virtual world is vital in students' engagement, and that moving virtual universities to less populated environments decreases the probability of immersion occurrence. Co-presence and interaction with each other are considered as necessary prerequisites for the achievement of students' in-world immersion, while moving to private hosted servers is even viewed by some researchers as “a missed opportunity to address some of learners' misconceptions and prejudices” [3].

Coming to a conclusion, it can be stated that Second Life usually gathers more features which lead users to immersion compared to OpenSim. However, this should not lead to the erroneous conclusion that the worlds created through the use of the OpenSim technology are not or cannot become immersive.

2. Research methodology

This study was based on prior empirical speculations, which were further investigated in a systematic way, through the conduct of structured interviews that led to the collection of substantial data and the drawing of clear and reliable conclusions.

2.1. Background

The viewpoint presented in [6] is essential to be cited at this point, since that was the starting point of this study. Based on observations, it was suggested that the highest levels of immersion are reached within Second Life, and this fact was attributed to the plausibility of the world and the wide network of interactions that occur within it. By contrast, the level of immersion occurring within the OpenSim worlds hosted by dedicated providers is limited at lower levels than those that occur in Second Life. Finally, regarding the institutional hosted OpenSim servers, in [6] it was pointed out that the levels of immersion which the student-residents are able to develop depend largely on the way universities select to use their virtual space. As also noted, students' immersion can easily be achieved into the university's virtual world, as the activities within it will become part of the students' daily life.

2.2. Grounded Theory

Qualitative analysis was considered to be the most suitable approaching method for the subject under investigation. According to Strauss & Corbin [17] the qualitative approaching of an investigational topic is the ideal option when not only the width of the phenomenon, as in quantitative researches, but also the details of that phenomenon, the stakeholders' viewpoints, motivations and feelings, and generally the links among the collected data are sought. The conduct of interviews is one of the methods of collecting qualitative data and was chosen for the needs of this study.

This Grounded Theory approach, as described by Strauss & Corbin [17], was therefore used for the collection and analysis processes of the qualitative data. A key principle of this theory is the formulation of conclusions that are not based on theoretical approaches, but grounded on primary data collected through various research methods, such as the interviews. By precisely this feature, i.e. the grounding of the theory on the data, Grounded Theory derives its validity and reliability, and this was the first reason why it was opted for the purposes of this research.

The second reason concerns the freedom that researchers are offered to creatively link the collected data. Thereby, all the inherent relationships between data, even those that are not obvious at first viewing, or those that were not anticipated in the research planning but arise in its course and add new queries and concerns for study and research, are discovered. Besides, the formulation of new questions during the course of the research is yet another feature of Grounded Theory, which is a valuable tool for any qualitative research [17].

Finally, in Grounded Theory, both the continuous posing of queries and questions, and the use of comparisons are equally valuable tools, and thus they constitute the third reason why Grounded Theory was found appropriate for the needs of this research. The Grounded Theory provides the opportunity to compare two or more groups according to multiple aspects and features, aiming at the best possible understanding of their features and the highlighting of the group that excels, not at first glance, but

considering all their potential different dimensions. According to Grounded Theory, there can be validity in the comparison between the viewpoints, ideas and perspectives of research participants as reflected in their answers, as a consequence of the various conditions under which they were formed [17]. This feature of Grounded Theory was a valuable tool for this research, as all views raised by educators were studied in relation to the context in which they were developed, and taking into account the factors that led to the contemplation of things as expressed during the interviews. Accordingly, the final comparison of the two virtual worlds that are studied in this research was made considering the various different factors that affect their features.

2.3. The Interviews

In order to fulfill the objectives of this study, a strategy for the evaluation of the levels of immersion experienced by students within each virtual world was formed. This framework was based on the findings of the literature review and was aimed at easing the investigation of students' immersion in virtual worlds during their participation in in-world educational activities. According to that framework, when students are immersed in a virtual world they perceive the in-world activities as effective, attractive, pleasant and experiential. Therefore, the following interview questions addressed to university educators were structured as to fully cover the subject of investigation:

1. According to your opinion, does the fact that your students may also use the virtual environment of Second Life/OpenSim to communicate with others and/or spend their leisure time, make your lecture more effective and attractive?
2. Do you think that the virtual environment of Second Life/OpenSim leads your students to "live" the lesson?
3. Based on your experience, do your students enjoy the educational activities within the virtual world more than the ones in the university classroom?
4. An important concern is thought to be the orientation; the induction process. What is your methodology to orient your students?
5. Since your virtual university is hosted in an institutional hosted server, do you think that the fact that your students don't constantly have the opportunity to interact with users who don't belong to your university's community affect negatively their immersion?
6. Based on your experience, in which virtual environment were the educational activities more effective and attractive? (Please indicate only one virtual environment).

It was thought to be meaningful not to ask educators directly about their students' in-world immersion, but on the contrary about the attributes conferred to the educational activities when students are immersed, since that way educators would have the opportunity to express their opinions about all the factors that make their in-world activities effective, attractive, pleasant and experiential. Besides, the scope of the educational activities that take place in virtual worlds is not to lead students to immersion per se, but to achieve their educational goals when students are immersed.

From February to May 2012, a total of 34 academics from various educational fields participated in one-hour interviews which were conducted via Skype or Second Life or face-to-face. The educators expressed their opinions based on the set questions. However, not all the questions were addressed to all participants. Besides, educators' empirical perspectives and not their guesswork was what these interviews were seeking for. Thus, the questions 1, 2, 3 and 4 were addressed to educators who had used Second

Life, or OpenSim (internal/external hosts), or both of them. The fifth question was addressed exclusively to educators who had used an OpenSim server hosted by their university. Finally, the participants who had used both Second Life and OpenSim were asked to answer the sixth question.

3. Views of Educators on the Generators of Immersion



Figure 1. The factors affecting the four dimensions of immersion.

As shown from the literature review, immersion is necessary for the successful implementation of the educational activities within virtual worlds. When students experience immersion, the educational activities become more empirical, more attractive and more enjoyable for them and they are also motivated to achieve better learning results. When educators were asked to answer whether the educational activities carried out in Second Life or OpenSim had these features, the vast majority stressed that the effectiveness, the attractiveness, the experientiality and the pleasure of the learning activities occur when students are immersed in the virtual world and engaged with the educational activities. Additionally, all this is influenced by a wide range of factors.

Generally, the immersion that students may experience within a virtual world during their participation in educational activities, depends on the network of interactions that take place in-world, on the students, the educational activities, the technical issues that may occur in each environment, as well as on whether or not they will be oriented during their first contact with the new medium. Figure 1 gives an overview of the precise parameters of each factor that affects the four dimensions of immersion, as revealed from the analysis of the collected data.

3.1. Orientation

Orientation plays an important role in the successful implementation of engaging educational activities. Many interviewees stressed that orientation is a vital component for achieving immersion, and some of them even mentioned that the first projects they carried out using a virtual world of their choice failed due to their omission to orient their students.

3.2. Students

Like any educational event, so are the learning activities that take place within virtual worlds influenced by the students who participate in them. The students' personality and familiarity with the virtual world determine whether and how effective these activities will be. Several participants reported that the activities carried out were not sufficiently effective for some students because the use of virtual worlds for educational purposes did not fit their personality and preferences. By extension, this fact affects the attractiveness, pleasure and experience arising from these activities. At the same time, the range of experiences that students gain through their educational activities depends on the extent to which they understand the value of the activities in which they participate.

Even though educators cannot take actions to change their students' personalities, they can, however, manage to help them see the value of the activities in which they will be involved and familiarise them with the virtual world through the orientation process. Apart from orientation, which is certainly vital, students can become more familiar with the virtual world spending time in it. Indeed, several educators mentioned that the more time students spend in-world, the more they engage with it, gain new experiences, exchange information and share their experiences with others. Finally, it is common opinion of many interviewees that students must participate actively in the in-world educational activities and not just watch them, because only that way they can experience them to the fullest extent possible, become engaged to them, and therefore feel immersed in the world.

3.3. Activities

Another factor that influences whether students will reach a state of immersion within a virtual world while using it for educational purposes is the activities in which they participate. The activities carried out in-world should have a clear purpose that indicates the implementation in the virtual world and also affects the way these are planned and designed. In particular, activities involving creativity, communication, collaboration and playfulness are more attractive for students. Furthermore, activities that encourage collaboration among students and make proper use of the tools and the

opportunities the world offers are more effective. Additionally, the participants noted that students experience the educational activities to a greater extent when it comes to experiments, role-play activities, simulations, action-based learning activities and activities which have virtual worlds as their subject. On the other hand, it is recommended that lectures not take place within the virtual worlds when the educator aims to hold experiential sessions. Indeed, many participants underlined that they avoid holding lectures in-world.

Moreover, it's worth mentioning that, according to several educators' viewpoints, the brief and innovative playful projects are the ones that please students and thus lead them to feel immersed. The novelty of the approach attracts students' interest and leads them to participating pleasantly in every new project. Concerning the projects' length, that should be both long enough to let students engage in it, and also brief enough at the same time, so that the students' interest caused by the novelty of the approach will not be eliminated.

Playfulness is a vital component for pleasant educational activities because it makes students receptive to learning, since they get engaged in learning activities and learn unconsciously. However, these activities should be neither too playful, since then the playful element disrupts students, nor miss playfulness, since that will not lead students to an easy engagement with the undertaken projects.

3.4. Interactions

The interviewees noted all the different kinds of interactions that occur within a virtual world as the most important factor in the students' way to develop a sense of immersion. They underlined the importance of exchanging experiences and ideas among the members of the student groups and between students and other users of virtual worlds. On top of that, one of the participants emphasised the influence of thematic groups operating in open virtual worlds, to the satisfaction of students' interests, a fact that leads to them being immersed in-world.

Therefore, it seems that the context in which interactions are carried out, the content and the components of these interactions are factors that determine the effectiveness of the learning activities that take place in virtual worlds. Based on that, it can be said that educators choose the virtual world based on the network of interactions they want their students to develop among each other, with the world and other users. Besides, when students have the opportunity to interact with the virtual environment, other members of their group and other users of the virtual world or thematic groups, they consider the in-world sessions as attractive and pleasant.

Significant difference was detected concerning the range and variety of the interactions that may occur within each virtual world. It was shown that in the virtual world of Second Life students have opportunities to develop a very wide network of interactions coming in contact with students and non-student users, becoming members in thematic groups, and visiting virtual sites which are not part of the virtual space of their own universities. All these help them feel immersed in the virtual world. Similar but less extensive are the interactions that occur within the OpenSim worlds hosted by dedicated providers. On the contrary, within the institutional hosted OpenSim servers, students have considerably fewer opportunities to develop interactions with the virtual environment and other users. This, of course, has a very negative impact on the development of students' immersion into the virtual world in cases when those interactions are a central axis of the educational activities. On the other hand, when

those interactions among students are helpful but not an essential component of the educational activities, then students can easily engage with the project and thus experience immersion.

All the above lead to the conclusion that the impact the students' network of interactions will have on their experiences gained from in-world sessions, depends on the purposes of the activities and the context within which these take place. Some educators reported that the interactions developed by their students within the virtual environment of an institutional hosted OpenSim server were enough for them to gain the necessary experience. Other educators stressed the importance of students' interactions with other non-student users and generally the development of a wide variety of interactions with other components of the virtual world that do not necessarily belong to their university's campus, and thus they opted to use Second Life rather than other virtual worlds.

3.5. Technical issues

Although a learning activity within a virtual world can be properly targeted and designed, as well as include all the elements mentioned above that make it effective, attractive, experiential and pleasant, the technical issues that may arise during its implementation decrease the levels of experience students gain and the levels of pleasure caused by the specific activity. Technical issues may arise either within Second Life or OpenSim and almost all participants have mentioned them as a significant disadvantage of the use of virtual worlds in education.

4. Conclusion

Both the literature review and the data analysis reveal that immersion is not an inherent feature of virtual worlds like Second Life and OpenSim. Its reaching depends on the synergy of multiple factors. In Section 1.1 the following of these factors were identified: the users' willingness to be engaged and immersed, the use of avatars, the coexistence of users and their interaction with others in the context of virtual worlds, the technical characteristics, the context of the virtual worlds, and the appropriate orientation of students in the virtual world. Similar conclusions were drawn from the findings of this research which are presented in Section 3. More precisely, it was shown that the unique personality of each student, the network of interactions that develops within each virtual world and the technical issues related to each one of them define whether or not students will be able to reach a state of immersion. A vital element in the students' way to immersion is their orientation, a factor that has also been identified within the literature review.

Regarding the above, however, the literature review and research part of this study differ in two points. What was given emphasis in the conclusions of the data collected from interviews is that, additionally to the factors mentioned above, educational activities carried out in-world affect the level of immersion experienced by students, as well. We assume that this is not named as a separate influence factor in the literature because it is integrated in the broader category of the various interactions that occur in-world. On the other hand, although the literature review highlighted the importance of the use of avatars for the immersiveness in virtual worlds, the interviewed academics

seemed to include it in the characteristics of the context of a virtual world that make it immersive, rather than recording that as a distinct factor.

On the issue of comparison of Second Life and OpenSim regarding the potentials of reaching a state of immersion in the worlds, the outcomes of the literature review and the primary data collected for the purpose of this study were similar. It seemed that in Second Life students are more likely to get immersed in comparison to OpenSim worlds. This is because Second Life brings together more of the conditions that must be met for the students to be immersed. Nonetheless, the OpenSim virtual worlds would be inappropriate to be considered as non-immersive. Within the OpenSim worlds of servers hosted by institutions or dedicated providers, students may reach a state of immersion, but this is a bit more difficult than in Second Life, since, within the OpenSim worlds, fewer of the above conditions are met.

These findings are in full agreement with the empirical speculations in [6], which are clarified, enhanced and justified through the study presented here.

Therefore, if the primary objective of educators who choose to use a virtual world for educational purposes is to lead their students in having an experience as immersive as possible, then Second Life is the best choice for that case. If this objective is important for the educators, but not the most important reason for using a virtual world for their courses, then it is recommended that they opt to use a virtual world created through the use of the OpenSim technology. More precisely, for moderate degree of immersion they may appeal to dedicated providers, while choosing a private hosted OpenSim server may lead students to experience immersion, but in a lower level compared to the other two types of virtual worlds. Nonetheless, in any case, students also “choose” whether and how much immersed in the virtual world they will feel, and this factor cannot be directly controlled by any educator. Instead, it is at educators’ discretion to design for their students such activities that turn a world, which theoretically does not satisfy all the conditions to be immersive, into immersive ones.

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Demo Title: The Cincinnati Riverfront 1848: A historical immersive experience

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Abstract: This project is a prototype build of augmented reality app for the iPad. In this first phase, the concept uses a set of digitized daguerreotype plates taken of the Cincinnati Riverfront in 1848. At a time when most photographs were confined to portraits, this innovative work attracted worldwide attention and survives as the oldest comprehensive photograph of an American city (<http://1848.cincinnati.library.org/>). With the use of the iPad, users will be able to experience the panorama in the context of the modern-day riverfront setting (phase I). Connecting with the mobile device accelerometer (phase II) will allow the position of the image to move with the user, and as they turn, they are able to see the panoramic image of the riverfront. This image of the modern-day waterfront would be over-laid with the images from 1848 panorama, allowing users to see the immediate difference between the current scape and that from years passed. Additionally, in the full version of this application, users will be able to zoom into the photos and interact with embedded historical content across different points on the screen. These features area demonstrated in the prototype build

Keywords. Augmented reality, education, iPad, history, photography,

Introduction

“On September 24, 1848, Charles Fontayne and William S. Porter set up their camera on a rooftop in Newport, Kentucky and panned across the Ohio River capturing on eight separate daguerreotype plates a panorama of the nation's sixth largest city, Cincinnati (Media 1.). The Daguerreotype View of Cincinnati, which came to be known as the Cincinnati Panorama of 1848, won top awards for its technique and artistry. At a time when most photographs were confined to portraits, this innovative work attracted worldwide attention and survives as the oldest comprehensive photograph of an American city (<http://1848.cincinnati.library.org/>).”



Figure 1. Set of ten Daguerreotype plates of the Cincinnati Riverfront taken in 1848

These daguerreotype plates were transformed digitally and are currently available to the public on a five-foot interactive display at the Cincinnati Public Library. However, access is currently limited to patrons who physically visit the library. As a rich piece of art and history, expanding access to these images by making them available through augmented reality will help maximize the reach of this educational primary source for students everywhere.

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1. Current Project

Current Project: This demo is a phase I prototype for a panoramic, immersive photographic experience using augmented reality (Media 2.). Users will be able to experience the panorama in the context of the modern-day riverfront setting. Users manipulate sliders to move between the two points in time and interact with historical content embedded in the application.



Figure 2. Screen shot of prototype build of the Cincinnati Riverfront 1848 iPad Application

Next Phase: Connecting with the mobile device accelerometer allows the position of the image to “move” with the user, and as they turn, they are able to see the panoramic image of the riverfront. This image of the modern-day waterfront is overlaid with the images from 1848 panorama, allowing users to see the immediate difference between the current scape and that from years past. Additionally, in the full

version of this application, users will be able to zoom into the photos and interact with embedded historical content across different points on the scene. They can then begin to experience modern-day contextual connections to history through immersive augmented reality.

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Towards a framework for the design of mixed reality immersive education spaces

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Abstract. Immersive Education is moving beyond just the use of virtual worlds to become more embedded into the physical world around us. Some attempts have been made to characterize this mixed reality space along a virtuality continuum, with a particular focus on the interface between real and virtual worlds and the emergence of inter-reality applications where virtual reality systems are coupled with real-world objects. Some researchers have proposed frameworks that aim to understand the affordances of 3-dimensional (3D) virtual environments. However, there is little support for practitioners and designers in creating mixed-reality education spaces. This paper attempts to address this issue by using an Augmented Reality learning scenario as the initial basis for the creation of an initial design framework that aims to characterize the learning benefits (or affordances) of this technology. This is then used to identify the technical challenges which underpin mixed-reality learning spaces, and where possible, supporting pedagogical frameworks, which can be used to guide the design process. Finally we suggest the future steps necessary to move this work forward, from an initial outline framework, with the intention of developing a practical tool to help practitioners and researchers make informed choices in this emerging field.

Keywords. Mixed-reality, augmented-reality, design, evaluation, pedagogy

1. Immersive Education and Augmented Reality

In this paper, we begin to conceptualize a framework for understanding and defining immersive learning environments, specifically those based on the use of augmented and mixed reality [2]. The purpose is to begin with this subset of technologies and expand the framework to apply across immersive learning environments in general. The collective wisdom across the disciplines of computer science, human-computer interaction, psychology and education are necessary for the building of effective immersive learning environments. Further, there is a need for the technical, pedagogical and cognitive aspects to be addressed holistically from the beginning of the design process.

Immersive learning is a term that carries significant ambiguity not only across disciplines, but also within them. In fact, some researchers [3] argue that *immersivity* itself is not a construct worthy of its own development since there are underlying constructs in pedagogy and cognition that ultimately lead to learning irrespective of any particular technology. We disagree, and argue that it is valuable to define *immersivity* across the multiple dimensions of technology, pedagogy and cognition,

particularly as we move into the use of technologies like augmented and mixed reality where the technology is also the context for learning. It is important in the design of effective learning environments, that designers and researchers can accurately describe not only the technologies and their uses, but also their affordances from a learning perspective.

Literature on the convergence of the technical, pedagogical and cognitive components and interactions within immersive spaces is nascent, and past attempts at classification and/or taxonomies fall short of fully describing the affordances of augmented and mixed reality. We argue that the emergent model cannot be represented with a linear or hierarchical representation because neither account for the consideration of multiple perspectives across disciplines, nor do they account for the interconnectedness between the cognitive, pedagogical, and technically defined dimensions. The development of taxonomies and frameworks to represent the technical components of augmented reality are well documented [1], and frameworks that represent the learning affordances in other virtual spaces like 3-D virtual worlds are abundant as well [3, 17]. However, there is little support for helping designers and practitioners bridge the gap between what the technology is and how the technology can benefit learning. Being able to articulate these features of augmented and mixed reality will help designers think about maximizing the cognitive and pedagogical affordances and help researchers more clearly articulate what it is about a particular immersive learning program or application that contributes to learning.

As a continuum, Milgram [1] is helpful at providing an initial framework for describing immersive education applications, but it is clear that further detail is required as we drill down into the technologies, and the pedagogical implications. For example, Milgram's continuum doesn't adequately define the display characteristics concisely enough to meaningfully describe the environment. As the technology progresses and there are more detailed distinctions between the display environments and user interactions, we need to be able to more precisely define the technology in order to recommend appropriate development and research approaches. We also need to map this to the underlying pedagogical and cognitive approaches. This paper is our attempt to start this process.

2. Augmented Reality Scenario

In this section we present a simple scenario for the use of Augmented Reality (AR) within an educational context. This is then used in the following sections to help develop and illustrate a framework to aid in the design of AR educational applications. As a general approach our intention is to map this concrete scenario onto the technological and pedagogical aspects that need to be considered in order to create an effective design. At this stage we recognize that this is largely speculative in nature but hope to build on this approach to produce a more substantial contribution that can provide the designer with a clear set of guidelines, and help them to identify the trade-offs and adjustments that need to be considered in order to embed immersive learning experiences in a course, project, or learning activity.

Augmented Reality Scenario:

A team of students is assigned the task of collaborating on writing software to build two desktop robots (based on BuzzBoard technology [12]) to play a simple game of football by pushing a large ball into a goal (illustrated in figure 1).

This is a common assignment for undergraduate Computer Science students. The assignment is structured in a way that each student assumes responsibility for building one function of the robot control system (e.g. obstacle avoidance, ball follow, ball pushing, goal finding, inter-robot communication). When combined into the final robot solution, none of these internal functions are visible.

In order to test and debug their robot the students will use standard debugging tools but this can often result in a disconnection between the problem abstraction and the behaviors as exhibited by the real robot. In this scenario, the students each use an iPad to point at the robot and see the invisible aspects of the robot (sensor data, process interaction) from various perspectives while discussing the problem. They can then combine as a team to develop the robot together.

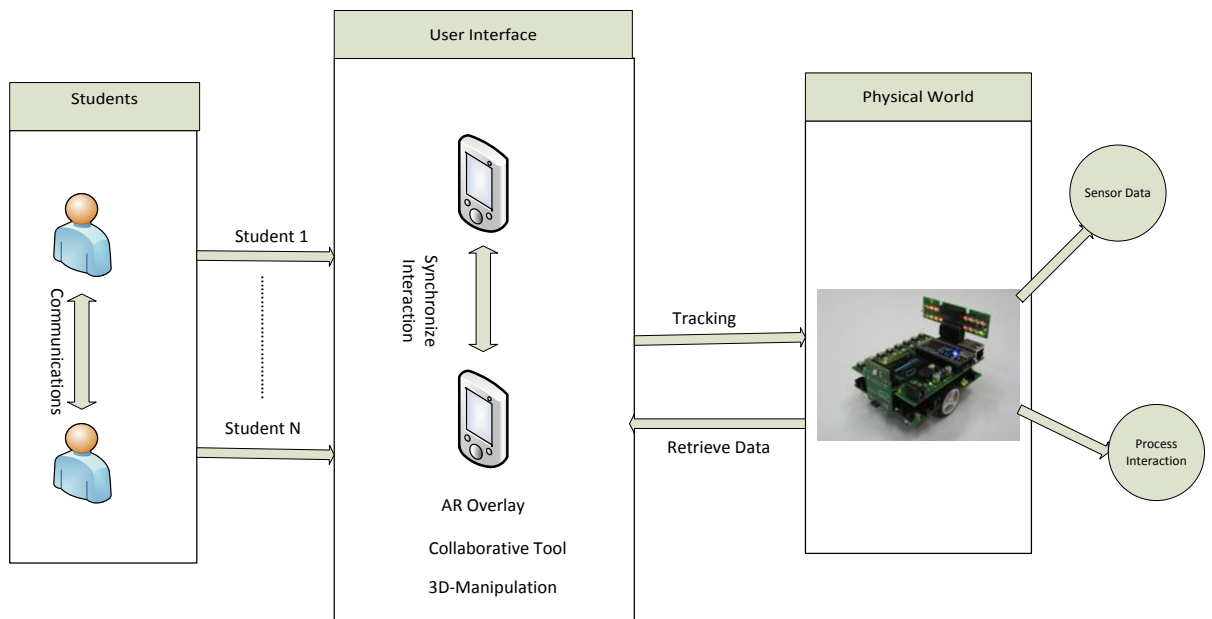


Figure 1. Augmented Reality Scenario

3. Design Framework

The above scenario can now be used to identify some of the key design issues that are illustrated in the following table. In terms of Milgram's virtuality continuum [1] this scenario mainly focuses on the 'Reality' and 'Augmented Reality' dimensions (Milgram's virtuality continuum is illustrated in figure 2). It is clear that this scenario essentially addresses the left hand side of this continuum, with the focus on augmenting a physical space through the use of handheld tablet devices. This is also clearly a mixed-reality example [2], as the real-space augmentation will be based around fairly complex virtual 3D representations of the real artifacts, with the augmented reality display being used as the user-interface to combine real and virtual objects into a coherent mixed-reality learning space/experience.

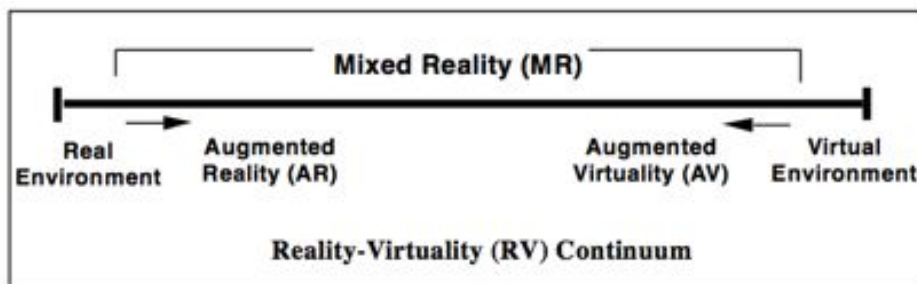


Figure 2. Milgram's virtuality continuum

A set of example 'use-cases' has been derived which describe specific functionality required by this scenario. These are for illustrative purposes only and we recognize that further analysis of the problem domain would be needed in order to capture and define a complete set of use cases based on this exemplar AR learning activity. The next rows of the table then attempt to identify the *technical challenges* associated with implementing these use-cases based around an initial set of headings. These headings are not intended to be prescriptive, as they provide only one possible way of structuring the technical challenges. Their purpose is mainly to open up the discussion around technical affordances and to illustrate some of the issues that are then described more fully in the subsequent section of the paper. The next step will then be to map the technical challenges to the *affordances* offered by these solutions and any underlying *pedagogical frameworks* that can be used to guide the design process. At this stage we have simply listed some known affordances of immersive education technologies and some example pedagogical frameworks. The main purpose here at this stage is to scope out the issues that will need to be more fully examined as we further develop this work. Ultimately our goal is to provide a coherent design framework, which as can be seen, is a non-trivial task with many underlying issues, some of which are described more fully in the subsequent sections of the paper.

Virtuality Continuum	Reality	Mixed/Augmented Reality
Use cases	<ol style="list-style-type: none"> All objects available to all students Objects can only be 	<ol style="list-style-type: none"> Modifications are notified to all students in real-time Information is presented in

	<p>modified by one student at a time</p> <ol style="list-style-type: none"> 3. Each student assigned a discrete sub-task 4. All sub-tasks need to be successfully completed to achieve the task 5. Instructor has global access to all objects 	<p>multiple views eg. real-world view, augmented view, plan view, etc</p> <ol style="list-style-type: none"> 3. Support tools are required to facilitate collaboration eg. change notification, group messaging, etc 4. All simulations/tests are logged 5. The instructor will have tools to edit/customise the learning activity and environment 6. Some functions will be location dependent (location of student, robot, etc)
Technical Challenges	User-interface	Haptics, 3D-manipulation, video image recognition, augmented overlays, collaborative tools, etc.
	Student	Modeling, assessment, support, learning, etc.
	Teacher	Learning activity design/modeling/programming, assessment, management, tutoring strategies, etc.
	Learning activities	Pervasive Interactive Programming, Learning Design, etc.
	Intelligent environment	Pervasive Interactive Programming, domain modeling, database search, etc.
	Devices	Mobile devices, location tracking, xObjects
↑ Mapping to ↓	↑ Mapping to ↓	
Affordances	Contextual Learning Experimental learning Engagement Collaborative learning Spatial Knowledge Representation	
Pedagogical Frameworks	Constructivism Social-constructivist Problem-based learning Situationist learning	

4. Technical Challenges

This section describes the challenges faced when implementing the above scenario. This considers both the real-world learning environment (RWLE) and how the desired or required capabilities and functionalities are implemented in an augmented reality learning environment (ARLE) / Mixed-Reality space.

4.1. User Interface

In the RWLE the user interface may consist of haptic devices to capture touch based interactions and other non-verbal communications and video image recognition. These interface elements are readily implemented in the RWLE; however, the challenge is how to integrate these into a cohesive structure that promotes collaborative learning. For collaborative learning, multiple students and an instructor must be able to not only view the real objects, but also be able to manipulate the underlying functionality as well. However, the AR user interface will combine both real objects and virtual ones (see Devices below). It will be composed of augmented overlays and contain collaborative tools that will allow multiple users to interact with the Learning Environment (LE) simultaneously. This could be accomplished by combining the RWLE and ARLE components into a single user-interface.

4.2 Student

The first challenge for the student interaction is how to represent the model (robot). This representation must be relevant and also be accessible at the structural level in order to allow for programming and control by the student. In [8], the author describes a platform that allows for this type of interaction with the student based on a technique called Pervasive Interactive Programming or PiP that aims to provide the user with non-technical tools to manipulate the design space [7 & 8]. The aim is that by removing the technical complexity of interaction with the model, the environment is more conducive to actual learning for the student. In addition, we will also need to consider how the AR can support the management of the learning activity steps that are being completed by the student.

4.3 Teacher

The teacher, as with the student, will need to interact with not only the model, but with the underlying functionality that controls and manipulates the model. In addition, the teacher will need to be able to challenge the students by setting up problems or tasks to test the students' knowledge and assess the progress made toward the curriculum objectives; in this case being the design of the robot to a set of specifications or performance metrics. The design of the learning task should also emphasize the affordances of the augmented-reality learning environment (see below).

The teacher will also need to be able to design and structure learning activities for their students. This learning activity management could be similar to that provided by LAMS International [10], which facilitates the learning design, and provides a set of 30 templates for designing learning activities. These can be edited and tailored to fit within the intended pedagogical approach of the teacher. The teacher will also need to be able to monitor the students during the learning activity, including the communication between students. In addition, they may need to intervene during the

session to clarify or explain the task for the students (for example, if they have misunderstood the objectives of the session).

4.4 Learning Activities

The IMS (Instructional Management System) Global Learning Consortium has defined specifications that can be used to create, plan and share a collection of learning activities that the students can achieve during an online session [5, 9]. These specifications have several benefits such as completeness, personalization, formalization, compatibility and reusability.

The integration between these Units of Learning (UoL) and a 3D virtual learning environment (3DVE) has been demonstrated in [6], whilst [5] proposes a conceptual architectural framework that delivers personalization content in MR (Mixed-Reality) immersive environments. The objective of the proposed framework is to perform the UoL in a collaborative space. This framework consists of several agents; such as an intelligent tutor agent, context-awareness agent, assessment agent and mixed-reality agent. The tutoring agent can suggest and evaluate new material for the learner, whereas the assessment agent determines the learning results [5]. To this end, implementing different tutoring strategies in the intelligent agent as well as in the other agents in order to create an affective learning design is one of the major technical challenges to be considered.

4.5 Intelligent Environment

The vision of pervasive/ubiquitous computing is to embed intelligence into our everyday lives, such as at work and at home. This includes the use of embedded computing and network devices that are controlled by intelligent agents in order to enhance the user experience as well as the general quality of life [11]. This technology has introduced a new relationship between users and the underlying technology, with the objective of making the technology both transparent and prevalent to the users [4].

A key challenge is how to program the environment to maximize the student-student and teacher-student collaboration. This could be achieved using Pervasive interactive Programming (PiP). PiP, as described in [8] and above, which is a paradigm designed to provide the user with control over the learning environment. The original premise also addressed issues such as security and usage by non-technical students.

AR within a pervasive computing space also now provides an opportunity for exposing and explaining some of the underlying functionality within an intelligent environment, for example ‘making the invisible visible’, and using it as an interface to the intelligent environment itself.

4.6 Devices

For the scenario here, the key devices that are used for the augmented reality applications are mobile phones, tablets or PDAs that will be able to control robot movement and track selected points on the robot. Typically these devices will also incorporate a camera and motion sensor [13], and will be handheld rather than head-worn as this has a greater impact on user mobility [14].

[15] has proposed two objects: xReality and xVirtual objects, that represent the interaction between the physical and virtual elements within an environment. The xReality objects represent both the physical and virtual/augmented forms and contains rules, that can determine the behavior and interactions with other objects (for example, this could be the BuzzBoard as seen in Figure 1). In contrast, the xVirtual objects can just be represented inside the 3D virtual environment, and they will have rules and behaviors that are associated with them [15].

For the proposed scenario above, the user/learner can point their tablet to the Buzzboard (xReality object) in order to retrieve real-time data from the network sensors within the Buzzboard. This is accomplished by using the attached tablet's camera. In addition, on the tablet screen, the learner then can see a virtual display (xVirtual object) of the invisible functionality/ information of the robot by using augmented reality. However, both display and camera are handheld, which allows for relatively free movement, and the tracked object has a fixed position (with a known orientation) [16]. The handheld augmented reality application will require a high degree of accuracy for both the position and orientation tracking so as to register the virtual object in the real-world learning environment (RWLE) [16].

5. Pedagogical Challenges

5.1 Immersive Learning Environments as Context

The use of technology in learning can be described from multiple perspectives. Schrader [18] described the technology in terms of the action or role of the technology. Schrader's work described learning *from*, *about*, *with* and *within* technology. Table 1. Summarizes this work. Students can learn *about* technology, where the technology itself is the content. For example, technology competencies, like how to use hardware or software would fall into this category. This use of technology does not require the teacher to adjust their pedagogical approach and learning is measured from gains or mastery. Learning *from* technology presents a space where the technology provides the content or *is* the teacher. Technology in this role provides an instructional affordance that learning *about* technology does not. That is, learning is thought to have occurred because of the technology and the technology provides the medium of instruction or takes on the role of instructor. Intelligent computer agents and drill practice programs are examples of learning *from* technology. Learning *with* technology is described by the cognitive interaction between learner and technology in which learning happens as a result of that process. This environment allows learners to engage with content in a way that helps them reach goals that would not be possible without the use of the technology. Lastly, Schrader's work describes learning *within* technology, in which the technology *is* the context. This can be used to describe MUVE's, virtual worlds, and virtual reality. The different types of interactions with technology are not mutually exclusive. For example, one could be learning *about* a particular technology, *within* a virtual world. Learning *within* technology creates a pedagogical shift that requires teachers to think about measuring outcomes in non-traditional ways (i.e. concept map analysis). Some of the affordances of the technology providing the context for learning include increased opportunities for interactions with other students (social constructivism), collaboration [22], and improved spatial understanding [3]. Learning

within takes on multiple modalities that transcend any one dimension of multidimensional learning spaces. That is they are interconnected, in the same way Jonassen [23] described situated cognition and the inability to disentangle cognition from the learning environment.

Type of Interaction	Example Technology	Pedagogical Approach	Technology Role
About	Any multimedia technology; i.e. programming, hardware, or software.	Varies, but content would focus on learning how a technology works, what it is, how to navigate; tradition pedagogical methods are appropriate.	Technology is the content.
From	AI, Drill, Computer Assisted Instruction	Technology is instructor; Delivery of content.	Delivery mechanism/instructor
With	Calculator (allows focus on higher level problem solving by freeing up cognitive space that would be occupied by lower level computation); concept mapping software.	Interaction with technology leads to gains in learning; deep engagement in constructivist environments.	Technology frees cognitive space for attention to higher level skills; learning results from cognitive interaction between human and technology.
Within	MUVE's; Virtual world; augmented reality - immersion.	Learning processes may not be directly observable/linear; teacher may be developer of designed experiences [27] may control/constrain rules and goals; create circumstances that lead to learning; less direct control.	Technology is a mechanism for interaction between content and experience; technology is the context.

Table 1. Schrader, P. (2008). Learning in technology: Re-conceptualizing immersive environments. *ACE Journal*, 16(4), 457-475.

Thinking about the use of augmented and mixed reality for learning from the perspective of learning *within* is important. However most of the literature on augmented reality considers the technology to be a mechanism through which content is delivered or defines it in terms of the interactions created by the technology. The authors argue that immersive spaces have to date been defined in terms that are too domain specific as to be meaningful for educational researchers and designers of learning tools and immersive learning environments.

deFreitas and Jarvis [17] have applied their four-dimensional framework, focused on context, representation, learners, and pedagogy to game-based learning in an effort to help practitioners make improved pedagogical choices. This same four-dimensional model [19] has been proposed as a tool for designing and evaluating learning in virtual worlds. This framework is one upon which we build our thinking about a model for immersive learning in virtual, augmented and mixed reality. The goal of the four-dimensional framework is slightly more practitioner centred than the goal of this work, with our focus being on informing a theoretical model that can be used for describing and designing and researching immersive learning from a holistic perspective. This includes the technology and its affordances for learning, recognizing from a situated cognitive lens [20] that the context cannot be separated from the learning process itself. Further, our framework involves the technology not only as an apparatus through which learning occurs, but for augmented and mixed reality immersive environments, it is the context as well.

5.2 Immersivity

Other researchers [3] have created frameworks for understanding the learning benefits of 3D virtual learning environments (VLEs) using a learner-computer approach that accounts for the role of representational accuracy (see figure 3). They cite increased collaborative and experiential learning opportunities as some of the learning benefits of 3D VLEs. However, they describe environments that cannot truly be defined as 3D from a visual display perspective because they are housed in a 2D desktop computer [21]. Dalgarno & Lee posit that the technical capabilities of the technologies create *immersion* and the individual's cognitive response to the 3D VLE creates *presence*. They argue that immersion and presence should not be considered as individual constructs since they are both the result of psychological interactions with the technology. Dalgarno & Lee define characteristics of 3D VLEs as falling under two categories, 'representational fidelity' and 'learner interaction', which lead to 'identity', 'presence' and 'co-presence', which lead to afforded learning tasks that result in learning benefits. In this model, the two broad categories with little definition, *afforded learning tasks* and *learning benefits* seem to be lacking in detail and the importance of their definition in the design of effective learning environments needs significant expansion.

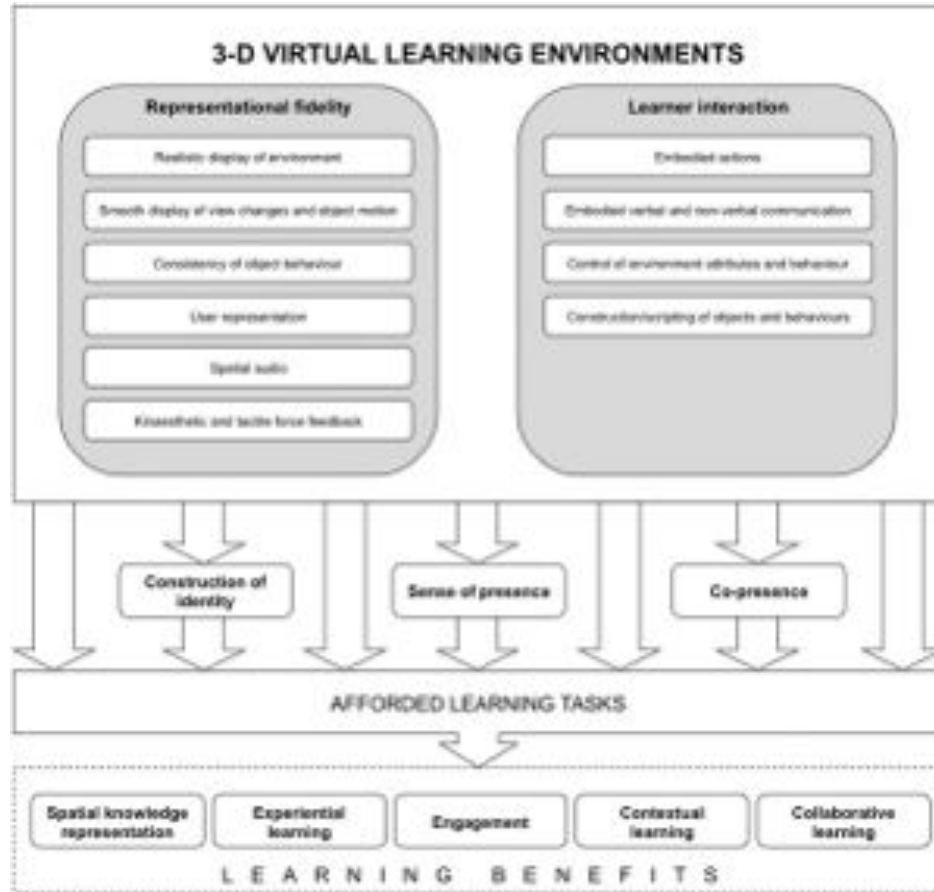


Figure 3. Initial model of learning in 3-D VLEs (Dalgarno & Lee, 2009)

5.3 Interconnectedness

We argue that pedagogical activities and affordances of the technology are but a layer in a more complex framework. Building on the previous literature, moving from the pedagogical perspective toward the inclusion of the cognitive perspective, this framework states that cognition and cognitive affordances are at the heart of effective immersive learning environments and that the technical components would ideally create a space that elicits certain pedagogical and cognitive principles that are effective for learning. However, the technical components are *part of* the learning environment, and as such should not be treated as separate, but interconnected constructs. That is to say, the technical, pedagogical and cognitive constructs, elements and their interconnections cannot be parsed out singly when characterizing immersive learning environments. *Immersivity* is part of the learning experience and the context, from which pedagogy and cognitive affordances cannot be separated. Understanding that these constructs are multidimensional and interconnected, we propose a comprehensive framework that defines immersivity along not only a visual display continuum, but also along pedagogical and cognitive continua that can express the specific affordances from this interconnected perspective. If we can better define the immersive learning

spaces that we are designing and implementing, then we can better understand the affordances of the immersive learning environment specific to the uniquely embedded and deliberate design. This gives us the advantage, from a design based research approach, of determining which specific factors in a particular program maximize learning. This framework combines multiple frameworks before it, but there is still a need to map this framework on to scenarios to determine if its value can withstand the litmus test of going beyond theory into becoming a useful tool for designing, defining and evaluating immersive learning environments.

6. Conclusion

This paper has taken the approach of using a simple scenario to illustrate some of the issues when designing and researching immersive education. The ultimate intention is to be able to build a tool that can map between the technical, pedagogical and cognitive issues in order to facilitate better design decisions. As can be seen, this is incomplete, and we still have some way to go - indeed we have only started to scratch the surface. The current scenario illustrates only one example of an immersive education approach. However, we believe that the scenario-based approach allows us to ground our decisions with real examples, which we hope to extend as we look at other uses for this technology. A key issue will be in mapping between these example use-cases and their associated technological challenges to the underlying taxonomies and frameworks that can also support the necessary pedagogical and cognitive design decisions.

Taxonomies have been developed that describe the technical aspects of immersive technologies [1], in addition to frameworks for describing learning affordances of virtual learning environments (mainly virtual worlds) [3] [19], but none have been able to sufficiently and completely capture the multiple levels and complex interactions between them in terms that can be beneficial to designers and researchers for accurately describing the technologies with which they are working and the affordances of those technologies for learning. As we move forward in the design of immersive learning environments, being able to better define and classify new tools and research is imperative.

Building on and interconnecting existing classification and taxonomic frameworks, we attempt to characterize learning in immersive environments from a multidimensional, layered approach, the very basic levels of which include, cognition, pedagogy and technical components, recognizing that immersive learning environments are complex systems in which individual components cannot be considered in isolation from one another.

Each of the frameworks mentioned in this article contribute important, but insufficient methods of characterizing immersive learning environments. We hope this paper is a catalyst for the discussion of moving toward a more effective way of describing and defining immersive learning environments. The authors solicit the contributions of researchers, designers and educators in the field to help build a framework that can more accurately characterize immersive learning environments towards the end purpose of building learning spaces that include the use of technologies and pedagogical practices that can maximize learning outcomes.

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VICERO – A Tool that helps you populate your Virtual World

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Abstract. When asking which Virtual World to use, people most often want to hear a one- sentence answer. Frequently the question leads to a discussion that can be compared to a debate about religion: you cannot be too sure which side you will choose but you are easily doomed from the beginning if you pick the wrong side (or in this case, platform). To help educators pick the right Virtual World platform we have developed a Scoring Model and Criteria Catalogue which support choosing the most suitable platform for teaching purposes. Educators (or business professionals) can use the Scoring Model to rate the criteria based on their respective demand. The Scoring Model will then suggest a Virtual World platform from a “long list” and instruct the educator how to install/use/maintain the platform. Thus educators will not be left alone with their choice and will get a motivational hint where to start and where to seek support. The “long list” is monitored and updated regularly so that selections are always up-to-date. We will demonstrate the tool and would be happy to receive feedback from the community to help further develop VICERO [1].

Keywords. Virtual World, Scoring Model, Decision Making

Introduction

“*There is no right and wrong. There's only fun and boring.*” said Fisher Stevens’ character “*Eugene Belford*” in the 1995 movie “*Hackers*”, whose tag line read, “*Boot up or shut up!*” Today’s educators may find this familiar: on one hand they have to entertain their audiences aka students or staff, on the other hand they are meant to educate them in a proper manner.

Educators wanting to use tools of the so-called “new media” face a great challenge. Setting up a tool like a Virtual Environment for e-learning must be considered a long-term investment. Especially installation and customization require considerable time and know-how. Moreover, knowledge of the tools e.g. Virtual Worlds available is also necessary. Many Virtual Worlds are still under heavy development, others may already be stable and mature but do not meet the requirements proposed by the educator. In the end many educators who started motivated and in good faith discontinue their effort to

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use a Virtual Environment for e-learning. Some educators did end up asking us for help since they did not want to surrender that easily. To be able to help them we began asking them questions, such as

1. What do you want to use the Virtual World for?
2. How many students do you want to reach?
3. What assignments/tasks will you give the students?
4. Do you have a server you can use? What does it run?
5. Do you have IT skills or someone who will help you set up the Virtual World?

Most often we got confused answers which led to long discussions. Even though we wanted to help the educators maintain their high level of motivation, we failed. Therefore, to respond to these kinds of questions more effectively, we created a checklist [1] which helped us plan the first steps. The checklist was well received by the educators but lacked one essential element: flexibility. It could only respond to model usage of Virtual Environments and did not address the different requirements of each educator. While some educators were already familiar with the technical demands of a Virtual Environment, they did not know how to present adequately to students or staff within the Virtual Environment. Other educators easily managed to present but did not know how to transfer files, etc. In the end we decided to develop a Scoring Model that would help them all – a Scoring Model that would react to each and every requirement, whether an educator wanted to use the Virtual Environment for team training, project management purposes or just simple distance learning presentations. It would also address the fact that different educators needed different tools and that different educators had different background knowledge of Virtual Environments. And thus “VICERO” was born.

Considering that Virtual Environments or Worlds are not just hype within the e-learning community, it was frustrating to see that many motivated educators failed when they tried to use a Virtual Environment/World, which then resulted in once motivated educators giving Virtual Environments/Worlds a bad name. Therefore, the Scoring Model project was not only considered a good idea but was also popular with the students who had to come up with ideas to build VICERO.

Based on the results of former research it was easy to come up with the relevant data to develop the Scoring Model. The fact that many educators mentioned gamification as a motivational factor was inspiring to the development process itself. Therefore a gamification rule was added to the project goals: “*The Challenge and Complexity of the Catalogue has to be seen in relation to the skill of the user to use it. It should not be too challenging or too easy, so the engagement of the educator to use it remains on a high level.*” [3] Although it was not planned to give out achievement points or badges to those using the checklist, this was considered to add gamification-related content to the Scoring Model itself. So, more experienced users of the Scoring Model should be able to “level up” and become “VICERO Ambassadors”. This idea

was abandoned during the design process as it became clear that this task would take up too many resources. The gamification rule also helped implement knockout criteria in the Scoring Model. This will aid educators who cannot be given advice suitable for their requirements. It was well considered that the answer “*Sorry, no suitable Virtual Environment/World could be found for your requirements*” would also be helpful for educators. It does put a stop to their search but simultaneously helps them focus on other tools like classic e-learning platforms or even offline practices. Nevertheless VICERO will suggest a set of basic Virtual Environments/Worlds to look at.

Demonstration

VICERO can be seen as work in progress (or perpetual beta), since the Scoring Model was just released for public testing and the mechanics of the Scoring Model itself are rather simple. Educators’ different skill levels are also considered a big challenge for VICERO. Therefore, the tutorials need intensive testing by the different kinds of educators in the field and feedback is greatly appreciated. The translation into other languages also is on a “would-be-nice-to-have” list. As VICERO is made available to the public it can be found at <http://vicero.virtuellewelten.at>. Using the Scoring Model is free of charge, but no warranty is given to educators following its advice. What is also worth mentioning is that the people maintaining VICERO have no commercial affiliation with any of the providers of Virtual Environments or Worlds. All advice given by VICERO is based on a neutral assessment of the Environments/Worlds. Therefore the demonstration will help interested users to evaluate the potential of VICERO for themselves and be able to have an impact on the ongoing development process. It will also demonstrate that VICERO is able to help them bringing new educators/clients/students/project team members into a virtual world.

In the end VICERO will hopefully help

- to eliminate barriers to the use of Virtual Environments/Worlds for learning,
- to make the right choice when selecting a Virtual World platform for e-learning, and
- to take first steps on "alien" ground,

because in the end it is not about "*right or wrong*" but about "*fun or boring*".

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Virtual Gallery Weekend Berlin :

An online shared spaces experimentation dedicated to Contemporary Art

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Abstract. This paper presents and analyses the results of an online-shared space experiment dedicated to contemporary art. The project was developed as part of the artistic event "Gallery Weekend Berlin 2012" from 26 to 30 April 2012. This 3D virtual space was available to the public using avatars and presented the showrooms of the fifty-one major Berlin's contemporary art galleries. Each virtual gallery was geo-located on a map of Berlin.

Our goal was to test a new form of mediation based on 3D web technology, preserving the social (socialization, communication, sharing) and the geographical aspect (location in the city) of the event.

Keywords. 3D shared space, metavers, online art gallery, realtend, contemporary art,



Figure 1. Virtual Gallery Weekend Berlin^{beta} (screenshot)

Introduction

From 26th to 30th April 2012 was opened the "Virtual Gallery Weekend Berlin^{beta}" (VGWB). This 3D space was accessible for the public through avatars and presented the showrooms of the fifty-one major Berlin's contemporary art galleries. Each virtual gallery was geo-located on a map of Berlin.

This experiment was about testing a new form of cultural mediation based on the 3D web technology, preserving the social (socialization, communication, sharing) and the geographical aspect (location in the city) of the event. The design and user experience of the platform was designed to be at the level of expectations of an

audience accustomed with the online edition of artistic content for the contemporary art international market.

This project was conducted as part of a partnership between the gallery owners of the event "Gallery Weekend Berlin 2012" and a group of member firms of the open source project realXtend: Spinningwire (production design), Adminotech and Playsign (software development).

The application was available online in two versions :

- One requesting application downloading and installation (called "Full Experience"),
- The other using standard web browsers with Flash (called "Light Experience").

During the experimentation, several digital measurements and observations were done: site traffic, visits, duration, movement, and observation of user behaviour by a team of assistants online and a form-based survey. From these measurements we will seek, in this article, to identify and analyse the difficulties faced by non-technical audiences in terms of:

- Accessibility (technological limitation, connection),
- Learning (user interface, mobility),
- User experience (content accessibility, communication, socialization),
- And uses (relevance of this new form of mediation to the public and professionals of contemporary art).

The goal is to identify qualities and constraints of this new form of mediation compared to traditional Web technologies.

1. Description of the experiment

1.1. Context

The project was born in 2012. VGWB is on the convergence of need related to methods of presentation of contemporary art online and the development of communication technology, online-shared spaces (Metaverse).

It is the result of exchanges between the members of the team of the artistic event "Gallery Weekend Berlin 2012" (composed of gallerists and curators), a group of researchers (EnsadLab/EN-ER), the iT developers (reaXtend) and companies working on space applications shared online in the field of art and communication (SpinningWire, and Adminotech Playsign).

The environment of contemporary art is especially demanding in terms of visual communication. Museums, galleries and artists do care about the presentation and development, both paper and digital. In this area, the websites are mostly simple in terms of graphic design and interface view. This is to highlight the content and forget the web medium.

Experiments have been developed to provide preexisting works in an alternative form to the web page type catalog. Among these, the most recent project "Google Art Project" was noticed. This is an application of virtual tour online. The principle is

derived from "Google Street View". It associate 3D geometry (for model space) and panoramic photo (for texturing volumes). On "Google Art Project", the user can view the art pieces in the context of their exposure. He can visit on subjective vision the 156 museums currently involved in the project. Also mention the website "VIP Art Fair" (<http://www.vipartfair.com/>), a contemporary art fair offering online purchase works of international galleries. The web interface is this time a 2D application based on a lateral flow: on a wall without end art pieces are presented as well as the documentation about it. A human figure can realize the scale. The user can make a purchase or contact the gallery concerned by e-mail or instant communication (chat text).

Translate the original art piece, whose medium is varied (volume, installation, painting) in a jpeg image is restrictive in several ways. It trims its plastic characteristics (size, material, texture, etc.) and prevents direct perception. Visitors to a Web Gallery are connected to a representation of the art piece, not a translation or an original creation designed for this new medium. Visits allowed by "Google Art Project" can place the Artwork in its original exhibition context.

The digital space preserves the scenography and staging, unlike a paper catalog or web 2D. However, the lonely visitor is facing the reduced representation of the work in static information.

This is the second subtraction: there is no shared emotions, interpretations or exchanges with other spectators. Space and pieces remain frozen. Time is not updated by the presence of the other. In short, present a single image of the art piece does not make sense.

Although showing some interest towards this type of media, gallery owners and curators of "Gallery Weekend Berlin 2012" are still quite reluctant. Their main criticism is these applications induce isolation of the user who does not retransmit a key aspect of the presentation of contemporary art: its social dimension. An active context is expected: the dialogue between the gallery and the collector is required.

It is not about proposing an alternative to meeting the physical and direct perception of the art works. It is about media coverage of an object or an existing proposal. The questions here are not performance (issue of pure presence, even radical [1]), or relational aesthetics (*esthétique relationnelle* [2]). The artistic field remains gallerists' and artists', outside the platform, but should be visible through it.

The social dimension must be found through the online presentation tool. On the web application "VIP Art Fair", despite the commercial potential, space of socialization in the gallery page is reduced to a 2D mediation, the gallery work to an act of sale and art pieces to commodity.

An interesting question appears: how to reconcile the informative power of the Internet (inseparable from its ubiquitous nature [3]) to the social dimension and localized space exhibition?

Among the new forms of mediation of the web, the use of online-shared spaces (3D worlds) seems the most appropriate. This is a space populated by avatars from a gradual migration of game technology to the Web over the past fifteen years. At first the games connected to the web community to allow players to access information on the web (Score, data, Tips and trix). Then, with the acceleration of Internet connections appeared MMORPGs [4] allow groups of players to interact and communicate in real time in the space of the game. These web technologies provide new uses than entertainment:

- Learning with the application of serious games, scripted spaces dedicated to the visualization and simulation situation for the purpose most of the time or educational professionals.
- Socialization and creation. User communities regularly meet on three-dimensional universe (Second Life type) to exchange script or build. Experiences exhibitions or museums have also been made with success, but limited to the audience of players of the virtual world.
- The sharing and exchange of information. Recently, with the development of web technology feels 3D simplifying access to its spaces, this new use seems to develop. It became possible for occasional use to connect to online space to access content (text, sound, image, object) and interact with their publishers or other visitor's item.

The use of shared space online responds to our question. It was accomplished on a research project whose objectives were:

- To develop experimental public applications, presented in the context of great artistic event in Berlin.
- Assess the maturity of the technology and the accessibility of applications.
- Assess maturity of public facing this new form of experience
- To evaluate the relevance of this new form of mediation compared to traditional Web.

To carry out this research, we wanted a flexible and adaptable technology (possibly open-source) and not requiring users to create an account to a specific community of players.

It was decided to experiment a new project open to the public as part of the artistic event “**Gallery Weekend Berlin 2012**”.

1.2. Concept

The project “Virtual Gallery Weekend Berlin 2012 ^{beta}” was created for the social art event: Gallery Weekend Berlin 2012. During one weekend, the 51 leading Berlin galleries open, inaugurating new exhibitions and inviting visitors to a trip through the creative scene of the German capital, offering own events and guided tours. During this week more than 10.000 visitors, art collectors and VIPs come to Berlin and move from gallery to gallery, visiting the exhibitions and art and gala events.

“Virtual Gallery Weekend Berlin 2012 ^{beta}” is an experimental 3D online application developed for visitors and non-visitors of the “Gallery Weekend Berlin 2012”. It is a virtual shared experience that allows an audience of users to:

- Identify and locate the participating galleries and prepare an itinerary for their visit in Berlin
- Visit online the virtual showroom of each gallery for a preview of the exhibitions
- Communicate with the gallery owners, share information and impressions with friends or other visitors

Before the event, this application allowed the visitors to prepare their trip to the Gallery Weekend. During the event, this application allowed the online users to virtually participate in the event, or navigate the real venues with the prepared itinerary. After the event, this application became a digital memory of the event.

Virtual Gallery Weekend Berlin 2012^{beta} is a shared experience; visitors are not alone in the 3D space. Through an avatar, they can explore the showrooms; meet members of the “help crew”, other visitors, gallery owners and assistants, while also exchanging impressions, thoughts and information.

The visitors accessed the application through a web page. They logged in either using their Facebook account or an ad-hoc identity created on-site. Each visitor arriving in the “Welcome Showroom” as an avatar was welcomed by the “help crew”. This group of people was dedicated to help the users to learn on how to navigate, communicate and utilize the application.

The space around the visitor is composed by a large flat map of Berlin on top of which there are localised the 51 floating showrooms.

Once the first instructions are received, the visitor is able to visit the virtual space. By a simple click on one floating gallery showroom, the visitor starts to fly above the Berlin map with his avatar toward the chosen gallery.

Each showroom is a communication and exhibition space dedicated to one gallery. Inside, six selected pieces of art from the exhibition are shown on walls. The other side of the wall showed information about the gallery and the artist on web-screens and video-screens. Visitors and gallery team can see each other as avatars and communicate by voice or text chat to share their experience and exchange opinions.

Showrooms are localized over the map to show the real location of the gallery. Having the chance to fly above them, the user can familiarize them with the actual gallery positioning in Berlin.

1.3. Artwork presentation and showrooms

One of the first issues raised with the gallery was the status of artwork represented in the application. There should be no ambiguity between the artwork and its representation in the virtual space. It should be clear that we present a reproduction, photography of the artwork. It was visible to the public in the photography integrating context exposure and by the credit for the photographer.

It seemed important to avoid confusion between the gallery space and its representation as showroom on the platform. Standardization of architecture showroom in the application and the presence of a photograph of the original gallery rose ambiguity.

Finally, the work should not be seen as a simple consumer product, it should be represented with the key information, a correct picture quality and at the scale of the original artwork // proportion to the avatar (for works inferior to 3m).

The exterior panels were used to present the context of creation and exhibition of works: Presentation of the gallery name and address, web site, photo gallery, biography and photo of the artist blurb works, video of the artist or webcam stream from the gallery.

The Showroom is a 20m x 20m box with a roof structure that disappears out of sight when the user is nearby. Six exhibition walls are arranged in a circle with paintings and information screens on both sides.

The internal zone is a circular exhibition space where visitors can discover a selection of six art pieces. The art pieces will display on demand by simply moving the mouse cursor above all the relevant information: (title, year of creation, artist, size, materials, photographic credits) With a click on a button, user can email to the gallery and request additional information about the artwork, a field enabled the galleries to give if she wanted pricing information (note that it is a little gallery is used).

The external zone is dedicated to information and communication. In this area, visitors get information about the gallery and the artists. The available information on the screens is e.g., web pages, RSS feeds, photos, videos, web-cam streams or additional artworks.

When the user is in the showroom the exterior walls become transparent allowing a clear view of the position of the gallery in relation to the map and to the other galleries. The visitors can always see the nearby galleries and they can fly to another showroom by controlling the avatar themselves or simply clicking on them.

Each gallery is able to host a maximum of 15 visitors at the same time. The 15 people inside the gallery are able to talk together by voice or chat by text. Alternatively a private way to communicate is also available, either in a one to one voice channel or one to one text messaging.



Figure 2. Showroom interior view

1.4. Spatial design and navigation

Spatial design of the platform was to meet two objectives:

- Locate the application in the city of Berlin
- Have a clean and simple graphic line based on information, to optimize the user experience.

The space is based on a map of the centre of Berlin. The 50 galleries participating in the real event are represented by flying box showrooms with gallery name, artist name, and address, precisely located on the map by a tail.

Moving the mouse cursor over a showroom box shows the gallery info, while a mouse click on a showroom makes the visitor's avatar fly over Berlin from gallery to

gallery. The presence of other avatars in the showrooms is indicated by a green dot above the showrooms, the visitors can immediately know where to go if they want to meet other people. Visitors can navigate the space by flying and walking freely, a global view of the map and a search function helping them to get a global overview of the space and find specific galleries or artists.

The visual design is simple and based on text information. It was inspired by the graphic style of "Gallery Weekend Berlin 2012" to assure a visual continuity with the physic event.

1.5. User interface and interactive communication tool

For this application, in order to minimize learning times, we designed a simple and user-friendly interface.

The avatar is primarily a spatial communication interface with other visitors. Its appearance has been designed neutral and not customizable. So visitors didn't spend time customizing their avatar's appearance as in a social virtual world. Instead they had a choice between a male and a female basic white avatar. The identity of each user in the 3D space is defined by the name and, if he used the Facebook connexion, the profile picture shown in the avatar banner. Members of the "help team" and galleries are identifiable by a different shirt colour. All the users can write and read in the public/private text chat, and talk with the nearby people by a public/private voice transmission system. A user list allows the visitors to meet each other and start remote communications.

Another priority was real time sharing information shown in the active screens (web, video player) around users avatars. When one of them takes control of a screen, selects a web link or starts a video, his actions are directly visible and the content is synchronized with other visitors. Everyone in the same showroom sees video at the same time. On some screens, users had access to real time information about the art fair: news (RSS feed and video news) or video streaming from the gallery (VLC).

1.6. Login, support and assistance, art setting tools

One of the most difficult aspects of this experiment was to provide a platform for a wide audience some without previous experiences in games. Evaluating the accessibility of the application was one of the major challenges of this experience.

To login into the application, a specific web page has been developed, including:

- Hardware and software requirements
- A basic login protocol in 3 steps (application downloading and installation, identification, avatar selection)
- Video tutorial, help and faq
- A text chat where visitors can contact the support team for help and tech advices.

A support team of tele-mediator welcomed the visitors arriving in the simulated space with their avatars. Screens with pictures and video tutorial were visible in the

welcome showroom. The crewmembers' avatars instructed the visitors on how to control their own avatar, communicate and move from a showroom to another. During the visit the users were able to ask for help or information to the support team avatars.

Several other tools have been developed to help the platform management:

- Art setting tools: A web database is used to setup the pieces of art shown in each showroom, together with related information (description, artist, date, size, material). The same web tool allows selecting the content of the video, web page, RSS and information displayed in each showroom.
- Server management: On a web page, the crew found a global vision of the servers opened together with the list of visitors connected on each one. They were able to chat or login the server directly from this server management page if help was needed.

1.7. Technical platform

The application was developed on the open source SDK realXtend Tundra. The realXtend Tundra SDK is a complete 3D multi-user application development kit. This choice was motivated by several arguments:

- This recent technology was adaptable to our needs.
- The successful experience with this environment during the previous project "ABC 2011".
- The full accessibility of the open source code.
- The opportunity to experiment two types of client: Tundra, a downloadable application that runs the OGRE graphic engine and WebNaali, a web browser integrated client.
- A thorough knowledge of the SDK by the development team.

We decided to develop two versions of the application. The objective was to compare and evaluate the two possibilities offered by technology in terms of accessibility and user experience. Both versions displayed the same content.

The first version is based on the standard realXtend Tundra application. This technology was tested in the ABC 2011 project. It guaranteed results and a correct user experience but it requires the user to download and install an application on his computer.

The second version is based on the experimental browser based realXtend client WebNaali, which uses Flash's Stage3D as the graphics engine. This solution guaranteed direct access to the application from web-browsers and it had to be developed specifically for the project, which gave us no visibility on the final result in terms of functionality and user experience. To meet the deadline, the WebNaali version was simplified: the avatars were simplified to an eye, showing always the position and direction of each visitor and the voice chat function was not implemented.

Two companies were involved in the software development: Adminotech, for the server hosting and the realXtend Tundra application (called "Full experience") and Playsign for the web browser version (called "Light experience").

For this experiment several new features were created or enhanced:

- By Adminotech for the Tundra version: custom avatar script, VLC video component improvements and synchronized VLC video player, mumble voice server, realXtend knet network optimization, art setting application, art maintenance portal and gallery setup tools, custom user interface.
- By Playsign for the WebNaali version: development of the web browser client WebNaali and adaptation of content to web version.

Both versions have been user tested and used by the public.

1.8. Software and hardware requirements

An important constraint is to manage the software and hardware requirements. 3D multi-user applications are new technology and run best on modern and powerful computers. Access to the application was limited to users with PC (for game or multimedia) and Macintosh not older than three years old. The application is not compatible with smartphones, tablets or iPad.

Software and hardware requirements are:

- For the “Full experience” - Operating system: Windows vista or newer. MAC OSX 10.6 or newer. Graphics card: Minimum 256 MB RAM, 512 MB recommended. Graphic card with Shader Model 3.0 support. Processor Intel Core 1.66 GHz or AMD equivalent, 1GB RAM, 2+GB recommended.
- For the “Light experience” - Minimal requirements is computer compatible with Flash 11.1 or newer and Chrome, Safari, Firefox or Internet Explorer web browser.

2. Analysis of results

The application was online and tested by a selected group of users two days before the public opening. It stayed open during the event from the 26th to the 30th April 2012 and remained open with the online assistance until May 5th. The application was presented throughout the event in the “Gallery Weekend Berlin” VIP lounge and at the ending Gala.

During experimentation, many digital measurements, recording of data and observations have been done:

- Traffic on the different pages of the website.
- Number of application downloads.
- Number of accesses in the application.
- Chat text exchange on the helpdesk web page with the crewmembers.
- Visit durations and movement of the avatars for the WebNaali version.
- User feedback questionnaire.
- Direct observation of users behavior in world by the help crew.

2.1. Accessibility (technological limitation, application download and access)

This table resumes the number of visits on the two platforms during the event. The “Light experience” was open to the public on the second day, so there is no result on 04.27.2012.

Table 1. Statistic of connections during the event

	2012.04.27		2012.04.28		2012.04.29	
	visit	Nb usr	visit	Nb usr	visit	Nb usr
FULL EXPERIENCE	451	180	285	114	248	88
LIGHT EXPERIENCE				345		314
Web site visit	3351	2941	2284	1996	1673	1457
Web login page FULL EXP	3626	1596	1721	867	1401	606
About page	494	421	347	280	364	306
Help page	229	184	115	95	57	46

Visit: number of visit

Nb usr: number of user with different identity

Full experience (Tundra standard application)

The application was open to the public between the 25th April and the 4th May. During this period 831 unique visitors (different identification) have accessed the platform.

During the three-day event 27th to 29th April, the numbers of unique visitors to the platform is averaged 130 users per day. This number must be compared to the number of visitors who accessed the login web page: 3069, around 1000/day. Only 12,5% of the users arrived on the “login webpage” accessed the 3D application.

Several reasons have been identified to explain this low percentage:

1) Users who do not try to log in the 3D space:

- The user looked at the login page but did not want test the 3D application.
- The user read the system requirements to test the 3D application and believed he cannot access.
- The user was afraid to download an application.

This percentage is difficult to estimate with our data. But some chat exchanges with the help team shows that a large part of the Gallery Weekend Berlin public tried to use a mobile device or old computer unable to handle the application. Few visitors reported that they didn't want to download the application.

2) Users who try to log in the 3D space:

- The user didn't understand the login web interface.
- The user couldn't download or install the application.
- The user couldn't open the 3D application because the requirements were not met.

Some users had problems identifying themselves but the major part was blocked by the installation of the application. The last part, by login in discovering that there hardware did not meet the system requirements. Comparing the data with the results of the “Light experience”, we estimate that 50% of the user login problems were related to hardware problems. Few improvements were done on the login and download interface during the 3 days with an increase in the rate of connections from 12% to 15%.

In the questionnaire, based on 55 responses, the opinion on the login process was mostly positive. This result must be balanced by the fact that the majority of visitors who responded were able to log in.

Table 2. Questionnaire question: Login process quality

Excellent	Good	Medium	Average	Bad
19,2 %	42,3 %	15,4 %	5,8 %	17,3 %

Light experience (WebNaali version, browser based client)

Based on the questionnaire and the web statistics we can estimate that around 40% of users (330/day) tried to test the “Light experience” during the event. Around 50% of them accessed the application. In this case the problems of access were mainly linked with not meeting hardware requirements.

Accessibility has been greatly reduced by two major causes:

- A hardware cause (around 50% of connection failure) related to the use of hardware not compatible with the 3D platform requirements. This problem will be resolved gradually with the increasing power of the devices, and the development of the compatibility between the 3D Web technology and mobile devices.
- A software cause (around 30%) related to the complexity of the login process (application download, identification). This problem seems to be largely resolved with the web browser compatible solutions.

This analyse demonstrates the impact of the login process on the user experience. Platforms based on downloading and installing applications are suitable to an experienced and regular audience, but those dedicated to a large public for a temporary use (like the VGWB project) must be web-browser compatible.

2.2. Learning (ownership of the interface and user mobility)

Just arrived in the application as an avatar, the users faced a new challenge: learning the interface.

Table 3. Questionnaire question: Is this your first visit in a virtual world?

Yes	No
45,5 %	54,5 %

For users with experience in virtual worlds (54.5%), learning the user interface was relatively easy. Inexperienced were assisted by the crewmembers on the platform.

The crewmembers teaching protocol had four stages:

- To contact the visitor: a crewmember avatar went in front of the visitor and tried to communicate with him by text chat or voice chat.
- Then, introduce to movement and point of view control.
- Then, explain how to communicate with others (only 12,7% of the visitor have used voice), use screen and media control.
- Eventually, show how to navigate on the platform (including using the map).

The presence of the help crew on the platform was essential. Thanks to them the first user experience was a social communication act.

Table 4. Questionnaire question: Virtual Crew service quality

Excellent	Good	Medium	Average	Bad
46,3 %	29,3 %	14,6 %	0 %	9,8 %

2.3. User experience (accessibility of information, communication and, social behavior)

Excluding time connections less than 2 minutes - mostly related to login problems (internet connection or insufficient hardware) - time of visits ranged between 15 minutes and 1 hour 30. That's considerably longer than of 2D website.

Learning motion functions by visitors has been fast. In their great majority, the avatars were mobile and evolved easily from one gallery to another. The principle of geo-located showrooms on a map has been intuitively understood and accepted by users. Visitors tended to visit the galleries or the presence of other visitors was reported. This behaviour indicates an instinctive socialization. Sometimes, users continued their visit together, without necessarily textual or verbal communications.

Most of visitors interact by voice or text chat with members of the help crew. The questionnaire related to communication between visitors is quite low.

Table 5. Questionnaire question: Did you interact with other visitors by?

TEXT CHAT		VOICE CHAT	
Yes	No	Yes	No
26,4 %	73,6 %	12,7 %	87,3 %

A few more than a quarter of them have engaged dialogues with other visitors. This result can be explained by the relatively low number of user in application due to problems of accessibility, and a need for anonymity on the one hand the visitors. Note that in a physical exhibition, visitors congregate in front of the artworks, but do not necessarily communicate.

For voice, this result is mainly due:

- No microphone or speaker.
- A lack of experience in the use of voice or a need to stay anonymous.
- An unfriendly interface, requiring the user to several manipulations to open the voice chat.

The artwork presentation was appreciated with more than 48.8% positive opinion, against 25.6% negative.

Table 6. Questionnaire question: Art presentation quality

Excellent	Good	Medium	Average	Bad
25,5 %	21,3 %	27,7 %	4,3 %	21,3 %

We have no specific information about the artwork consultation in “Full experience”. But the analysis of the avatar trajectories in “Light experience” shows significant use of zooming in and automatic art visit function.

42.6% of visitors were moved to Berlin for the event. Among them 42.6% reported that the 3D application was a useful tool to select the galleries they want to visit during their presence in Berlin. 53.1% of visitors who have not made the trip to Berlin have felt closer to the event with the application.

Table 7. Questionnaire questions:

Did you also visit the real Gallery Weekend in Berlin 2012?	
Yes	No
42,6 %	57,4 %
If you also visited the Gallery Weekend in Berlin, Did the Virtual Gallery help you to get an overview and select the most interesting galleries for you?	
Yes	No
42,6 %	57,4 %
If you haven't been in Berlin did the Virtual Gallery help you to feel connected to the real event?	
Yes	No
53,1 %	46,9 %

Results indicate the experience was positive for the major proportion of visitors who accessed the application.

In the open question: “Please enter ideas / remarks to help us to improve the experience”:

- Users report lag problems (internet connection) and an interface too complicated.
- Requires an application compatible with iPod and iPhone, and ask when the application can be use for augmented reality.
- Make comments, very positive or very negative about the experience

This experiment is being debated, with a sizeable proportion (about 20% share, and others) to very favourable (excellent) and very unfavourable opinion (bad). This opposition was also online in between some users frustrated by having had to use all this technology to access to information, with those excited by the social and interactive dimensions of the application.

Conclusion

As an experience, the "Gallery Weekend Berlin 2012 beta" has met its objectives. Thanks to the hard work of the team, on-line application proved stable. Technology choice, concept, design and user experience have been tested and evaluated in real conditions, facing the audience.

This experiment demonstrated that the use of online-shared spaces for cultural mediation was now feasible. The positive feedbacks from professionals of art and from visitors show that this form of mediation, information sharing space based, meets an expectation. Experience does not replace a physical confrontation to the artwork. Nevertheless, it allows another meeting. The viewpoints on the art piece's reproduction, the exchanges it causes, visitors' communion and empathy [8] in a shared time and space, weave a set of intersubjective relations. These generate, around the art piece's representation, a live relationships mesh, whose the art piece is the center as blind spot. Art piece's indication refers to its absence on the platform. Around it, through their avatar and communication tools (text chat and voice chat), the visitors' synchronization induces actual relations and exchanges.

However, this experience also demonstrates the technological and ergonomic weakness and immaturity of this medium to an untrained public. These weaknesses reduce the accessibility of content. These constraints should be resolved soon with the fast evolution of technologies: rise of hardware, client devices and web browser compatibility, cloud computing.

From ergonomics, user interface design and user experience design side, we note a contradiction. Current interfaces, inherited from video games, are adapted to a frequent use of the same application. But the design must be reconsidered for the "Virtual Gallery Weekend Berlin 2012 beta" type of applications. Here the user comes to consult content. He has only few minutes to devote to interface understanding. Simplification and standardization of ergonomics basis functions must be conducted (moving, communication, interaction with content).

Adaptation and learning difficulties appeared in front of this new form of mediation. Users with a gaming experience have easily taken over the application. Others have sometimes been greatly confused face this new experience. For them, learning tools like training scenario, tutorial and FAQ is not enough. Contact with an online helping team is invaluable. The adaptability of the gaming audience suggests that these difficulties will disappear with the progressive introduction of this new form of mediation towards the public. Eventually, it should be more intuitive than some 2D websites.

We identify two types of uses of online-shared spaces developing. On the one hand, spaces or closed worlds are dedicated to group, frequently used by a community (school, company, training, conference room...). The user comes up regularly in this space for a particular purpose. He spends time to form himself and invest the place. In this type of use, loading of a specific application, interface learning, or even upgrade the hardware is quite possible looking to benefits and time spent in this space. Current technology based on client applications (such as Tundra) is adapted for this purpose and offers the best results in quality of experience terms.

On the other hand, open spaces are dedicated to a large audience. User visits to perform a specific action (access to information, make a purchase, participate in a public event). In these cases a web-browsers solution associated with a simple and standardized interface seems unavoidable.

The space design made for "Virtual Gallery Weekend Berlin 2012 beta", based on standardized located showroom on a map, was adapted to such use. Simple to implement, this spatial information has been accepted and used intuitively by users. The information held in the space on a map becomes more accessible, concrete and easily stored for the user. The standardization of showrooms optimizes the exchange of data. In addition, it allows to imagine, and opens spaces on a world map on which the information would appear in the interests of the user.

This concept could be applied to many other uses requiring both a social exchange and location. It could be an alternative, more effective, easier to implement and less binding, than trying to rebuild totally some cities. This could be used as a grid portal, spatially structuring and centralizing cyberspace. Each showroom can be linked to a dedicated and specific use or community. Its adaptation in augmented reality will be easy since the showroom link existing buildings. The application would then increase the urban space.

Following this experiment, several new projects are being developed. The aim is to explore, understand and use the best features of these new three-dimensional mediums emerging since 10 years. With hindsight, we can see that the understanding of the aesthetic and cultural impact of new media is a long process. It involves not only technological but also learning and questioning our complete thinking and communication, both from the designers and users. It took over 40 years for the moving picture of the late 19th century to become a recognized and specific medium: cinema. It may take several decades to be able to identify social and aesthetics impacts of this new 3D medium.

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Educational games Sandbox I and II

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Abstract. Bringing serious gaming and gamification into Salpaus Further Education classrooms and more precisely to the Housing and Construction curriculum. Students are provided a two-part 3D game where they have to build a house according to Finnish construction standards.

Keywords. building, construction, game, gaming, 3D, virtual, immersion, engagement, creativity, risk free environment

Introduction

The Sandbox project, financed by the Finnish National Board of Education and carried out by Salpaus Further Education in 2010 – 2012, is divided in two main parts later referred to as Sandbox I and II.

The main objective of this project was to bring serious gaming and gamification into Salpaus classrooms and more precisely to the Housing and Construction curriculum and to provide Salpaus students with a two-part 3D game that would help them better assimilate the theory delivered in a traditional way up until now.

Sandbox game consists of building a one-family house according to Finnish construction standards. All the situations, rules, conflicts, conditions, behaviour and programmed tasks are genuine and reproduce real construction site situations and standards as closely as possible. We first build the foundations of a Finnish house and then in Sandbox II we continue building the house from the foundations to the roof.

1. The Games Sandbox I and II

1.1 *Sandbox I and game phases*

We divided the first part of the game (Sandbox I) in six building phases

- Choosing the correct clothes and drawings
- Starting the excavations and place the building lines
- Starting the foundation base
- Framing the walls
- Filling the foundation
- Finishing up the slab-floor

1.2 Sandbox II and game phases

We divided the second part of the game (Sandbox II) in eleven building phases

- Installing the posts and beams
- Finishing the superstructure
- Installing the roof panels
- Insulating the house
- Finishing the roof
- Windows and doors
- Installing the partition walls
- Facades
- Building the smoke flue
- Waterproofing the wet areas
- Interior finishing



Figure 1. The student first chooses his/her in-world identity

2. The world RealXtend

The 3D environment is RealXtend. RealXtend was chosen because of its open source dimension and the ease of modelizing the construction of a house.

RealXtend enabled us to give the students involved in building the house an avatar more naturally than any other game environment, which supported its choice as our 3D environment. Avatar movement could be programed as will, thus presenting theory via the virtual world in a more agreeable way to students.

The game was achieved including all these following features and functionalities:

- Games meet in one place via IP numbers and client server architecture
- 3D and audiovisual virtual environment
- Dynamic and editable 3D environment (space, buildings, object, documents)
- Media links to external world
- VOIP feature enabling in-world gamers to communicate
- Possibility of choosing avatar shape and identity (FaceGen)
- Editable interface
- Bot technology, spectators and instructors present in-world
- Scalable server architecture for further development
- 3D experience and engagement focuses on content and functionality

3. Teachers and students

Teachers have recently noted that traditional ways of teaching theory to VET students is increasingly challenging as students' attention is easily distracted by the latest computer games.

Bringing theory via a 3D game closes or aims at closing the gap between the school institution and the students' own world. Throughout the game students will engage easily with their peers through team work and apprehend difficult concepts of house construction in a risk free environment and commit themselves more easily to the learning tasks.

It was important to set up a team of experts in gaming, graphics and programming, who could develop the game in accordance with a given and specific curriculum study unit, whose pedagogical aspects were ensured by Salpaus educationalists.

4. Financer, client and designers

4.1 The Finnish Board of Education, the financer

The Finnish National Board of Education (FNBE) is the national agency subordinate to the Ministry of Education and Culture. The FNBE has a wide range of tasks related to the development of education all through pre-primary and basic education, general and vocational upper secondary education and training, adult education and basic education in the arts.

FNBE is responsible for drawing up the national core curricula for pre-primary and basic education and general upper secondary education and the national qualification requirements for vocational education and training and competence-based qualifications.

4.2 Salpaus Further Education, the client

Salpaus Further Education is a regional college providing secondary vocational education and training, staff development services and general upper-secondary education in the Lahti region.

Salpaus provides vocational upper-secondary and adult education and training in the fields defined by the Ministry of Education: Humanities and education, Culture, Social science, business and administration, Natural sciences, Technology, communication and transport, Natural resources and the environment, Social services, health and sport, Tourism, catering and domestic services. Furthermore, the Ministry of Education has granted us a special commission to arrange vocational education for athletes as well as to general upper-secondary education with a technical bias.

With a competent staff of over 800 persons (some 550 teachers) we train each year more than 20.000 students in secondary and continuing vocational education, of whom

- more than 5.000 strive for a vocational qualification
- some 200 for an upper secondary school diploma
- over 15.000 pursue studies in adult education.

4.3 The designers, Ludocraft Ltd. and AduSal Oy

Ludocraft Ltd. for Sandbox I and AduSal Oy for Sandbox II were the companies that helped us achieve and carry out the Sandbox game giving the Housing and Construction department of Salpaus further Education a new approach of learning.

4.3.1 LudoCraft Ltd.

Ludocraft Ltd. is a dynamic games studio based in Oulu, Finland. They specialize in the design and development of collaborative multiplayer games for PCs by harnessing high-end 3D game technologies. They developed Sandbox I in co-operation with Salpaus teachers and designers.

4.3.2 AduSal Oy

Founded in 2011, AduSal Oy is a dynamic Finnish company based in Lahti, Finland. AduSal Oy specializes in gaming and developing augmented reality applications in full partnership with Total Immersion, a French software editor.

AduSal Oy's scope of activities is:

- Games in 2D or 3D environments (RealXtend, Unity3D or any other game engine)
- Augmented Reality applications
- Mobiles applications for iOS, Android or Win 8 platforms

Sandbox II was designed by AduSal Oy only in full co-operation with Salpaus teachers and designers.

5. Demonstration of Sandbox games in Paris

Salpaus representatives will introduce Sandbox parts I and II in general. That will take 3-4 minutes then a video will be played. The video will show how avatars progress in the game and build the house. The video will last 6-7 min

Comments will be given orally by Salpaus representatives as the video will be played and time will be reserved for comments or questions from the audience.

References

Sandbox 1 was one of the six finalists in the annual eLearning competition called eEemeli, which is arranged by the Association of Finnish eLearning Centre in 2012

<http://www.eoppimiskeskus.fi/eemeli>

6. Reviews (sent to us)

6.1 Review 1

The paper describes a project („Sandbox“) that aims to support students in learning. In particular, the Sandbox game (consisting of 2 parts and using a 3D environment)

should help them to assimilate the theoretical learning material. In Sandbox I, students have to build the foundation of the house (according to Finnish standards), in Sandbox II, they have to finish it up to the roof.

The idea of the project and the game is indeed very interesting and is definitely worth being presented at EIED. However, the paper is far away from the quality of a full paper (if it was expected to be a full paper – it is not explicitly marked as a demo or a poster). Even if it is submitted for a demonstration/poster, the information about the project is quite sparse and unstructured. For instance, if the authors submit for a demonstration, they are asked to describe how the tool will be demonstrated at the summit – there is (except of the last very nonspecific sentence) no such information in the manuscript.

Some of the issues:

The authors do not follow the guidelines for submission (template etc.). Following the guidelines would give the manuscript also more structure.

There is not even a title included in the manuscript Each paragraph consists of one or maximally two sentences which makes it quite hard to read No references are provided It would be helpful to put in some figures It would be better to integrate the credentials into the text and not to present them at the beginning of the paper. The (interesting!) project should be the main part of the manuscript, not the credentials. In addition, the project should be described in greater detail (e.g., how do the phases of the game look like; who were the students who used it? Are there already any evaluation results? etc.) Please also check the English; the sentences are often far too long and grammatically incorrect

6.2 Review 2

The paper is about the project and pedagogical game « Sandbox I and II ».

The main objective of this project was to bring serious gaming and gamification into Salpaus classrooms.

The project is very interesting and should be of great interest for research community. However, this is not a full paper but an abstract for a demonstration.

Immaterial Art Stock:
preserve, document and disseminate the
pioneering works of art created inside
online immersive platforms

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Abstract. *Immaterial Art Stock* is a research project dedicated to preservation, documentation and public presentation of pioneering digital works of art created inside online immersive platforms (such as Second Life, OpenSim, etc.). This paper will present the main purposes of *Immaterial Art Stock* project: preserve, document, disseminate and developing reflection on the status of these works of art, their preservation and presentation protocols. The conservation of these works raises issues including software planned obsolescence, program compatibility, or the transience of certain works of arts. Through this contribution, these subjects will be dealt and we will also think about more sustainable safeguarding actions than currently used.

Keywords. Second Life, OpenSim, virtual work of art, preservation, exhibition, museum.

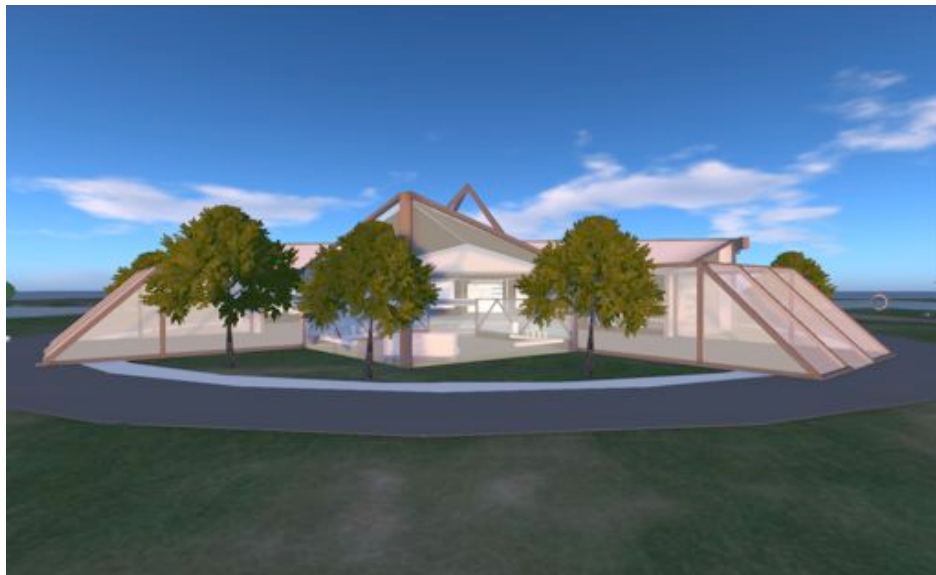


Figure 1. The *Immaterial Art Stock* museum in FrancoGrid (screenshot)

Introduction

Immaterial Art Stock is a research project initiated by the EN-ER laboratory (Digital Space and Extension of the Real) of the Ecole Nationale Supérieure des Arts Décoratifs, dedicated to the preservation, documentation and dissemination of pioneering digital works of art carried out in online immersive platforms (such as Deuxième Monde, Second Life, OpenSim, etc.). Since 2003, these spaces are invested by artists who develop pioneering artistic experiences with this new medium space.

This paper will examine the main purposes of *Immaterial Art Stock* project: preserve, document, disseminate and developing reflection on the status of these works of art, their preservation and presentation protocols.

In the first place, it will be necessary to give a historical overview of these platforms and artistic practices in order to extract the characteristics and potential problems. In the second place, we will determine the conservation and exhibition protocols for the *Immaterial Art Stock* museum. Following project presentation, we will observe issues related to the conservation of these works of arts. What is the nature of an work of art moved from its original context? Is it only a "documentation" of the original work, a fragment, a ghost or a reproduction?

The conservation of these works raises issues including software planned obsolescence, program compatibility, or the transience of certain artistic devices. Through this paper, these subjects will be dealt and we will also think about more sustainable safeguarding actions than currently used.

1. Context

1.1. History of online immersive platforms

Since the 1980s, we saw evolving the concept of online immersive platforms named "virtual worlds". The evolution of technologies and greater acceptance by the public of these new spaces (with the advent of social networks), have seen the emergence of new worlds to explore. Until now, these areas involved the use of a third party program to navigate. But in the foreseeable future, these spaces will be accessible through a web page that does not require any program, except the browser. Also, the multitude of present and future digital media offers to the visitor many more mode of assessment of this new medium. A virtual world is artificially created by computer software and can accommodate a user community, as avatars can move around and interact. It is built in two or three-dimensional spaces. These spaces replicate or simulate the real world, but also any other type of representation of a fantasy space. It is possible to integrate or not real-world rules such as gravity, weather, climate and relief. Virtual worlds can be used in various fields such as education, socialization, recreation, collaborative work, architecture, military or medical side.

Now, we will give a non-exhaustive overview of programs and projects that evolved immersive platforms, from their beginning until today.

The first to foreshadow the online immersive platforms, as we know them today, are French. This immersive project, born in 1997 at the instigation of *Canal + Multimedia*, was called Deuxième Monde (which later inspired Second Life). It allowed visitors to explore a replica of Paris as an avatar. First as a CD-ROM, it was converted, a year later, in VRML accessible space via the Blaxxun plug-in. The

Deuxième Monde was not really a game but an immersive simulation. It was the first French persistent universe welcoming thousands of users between 1997 and 2000.

In 2003, Linden Lab created a virtual world called Second Life. Users connect to SL as an avatar and interact with each other *via* a text, chat or voice. They can acquire land in order to develop their projects. Second Life is a meeting space and free creation environment that will see the development of art, debates and conferences, exhibitions, concerts or spaces for serious gaming (related to the training). Therefore, the platform introduced money exchange, having its own economy, based on the Linden Dollar. This currency is converted into U.S. dollars on a stock exchange operated by Linden Lab.

In addition, many other virtual worlds have been developed as Active world (1995), Entropia Universe (2003), There (2003), Kaneva (2004), Mamba Nation (2007), Cloud Party (2012) and many more.

In 2007, OpenSim, under the leadership of Second Life, paves the way for “open source” immersive worlds. Following this initiative, many “free-grid” projects appeared (as FrancoGrid, Logicamp, New World Grid, Osgrid, etc.). Based on technology similar to Second Life, these grids are free hosting spaces for users. In 2010, we could already see over three hundred other types of virtual worlds.

1.2. Operation and characteristics of online immersive platforms

What is an online immersive platform? A platform is an online 3D immersive space accessible to a person with an Internet connection. This space can take different aesthetic forms, but the way to navigate is quite similar. To connect several prerequisites are necessary: a laptop or desktop computer (other digital media such as tablets and mobile phones will expand the entry points of these mediums), an Internet connection, a remote or local server for hosting and distribute content, a program to connect and navigate within these spaces (e.g. OpenSim, RealXtend, Second Life, etc.).

During our research field, we listed a number of characteristics inherent to virtual worlds, on which we must study for the rest of the project. The peculiarity of immersive platform is that it allows multiple people to communicate in real time in 3D space. Close to video games aesthetics, these platforms offer alternatives to those usually associated with these games. The user can talk *via* a chat, talk directly or hearing the voice of the caller. It also has the ability to exchange documents, watch movies or listen to music. Besides these functions, the specificity of these spaces is especially the possibility for visitors to model together directly inside these worlds without going through a third party program. This makes these areas a dynamic medium: visitors become actor and content creator, they are no longer bystanders.

Another feature of these platforms is their persistence. Persistence may be defined by recording in real time on the servers, all actions performed by users. Yet, the term persistent does not mean that these platforms are sustainable in the long term, however, they are unstable over time, likely to disappear overnight. This instability is inherent to this medium and is due to several factors such as financing, the evolution of machines, updated software, or the technical bugs.

1.3. Pioneering virtual works of art history

From their creation, virtual worlds have been the site of various experiments and many artists have experienced in these areas. Considered by artists as a new medium, they quickly exploited their technical and aesthetic characteristics, to the emergence of new artistic forms. These practices are recent and our study is ongoing, we will develop in this section a non-exhaustive overview of different art practices.

Yann Minh [1] cyberartist, multimedia artist and founder of Noonantes (neo-cyberpunk movement), exhibits at the center George Pompidou National Art in 1983, *Media 000*, describing a multimedia immersive virtual world installation. In 2004, he directed the *3D Gallery of Las Meninas* in an early version of 3D real time NooMuseum, designed with the game engine Unreal Tournament. In 2007, he moved the gallery space in Second Life.

A group of groundbreaking artists in *Second Life*, named as *Second Front*, are engaged in creating performances. By 2006, this group, consisting of eight artists, produced numerous performances (with dancing, music or theater) and critical humoristic point of view of art history (for example, they diverted the famous *Last Supper* by Leonardo Da Vinci).

From 2006 until 2010, artists Eva and Franco Mattes have reproduced the iconic performances of art history (*Marina Abramovic's Imponderabilia*, *Valie Export's Tapp und Tastkino*, etc.) questioning the body perception within the immersive platforms [2].

Fred Forest, digital artist, pioneer of video art, has experienced new media and created the first interactive environments since 1967. In 2008, he created in *Second Life*, a *Social Laboratory and experimental Territory*, which purpose is to initiate within a virtual space an active political participation, materialized by the "laboratory of ideas for the future". Several critical works will follow (*The bullfight* in 2008, *Cyberstar Ego* in 2009 and *The Trader's Ball* in 2010)[3].

Since 2007, Patrick Moya, known as Moya Janus in *Second Life*, is a prolific artist creating murals, installations, live paintings, ceramics or even happenings. His protean work extends over several thousand square meters. The artist considers virtual worlds (Second Life, Kaneva or FrancoGrid) as worlds to inhabit and explore.

More recently, Chris Marker, with Max Moswitzer created in 2008, *L'Ouvroir* (referring to the OULIPO, the Ouvroir of Potential Literature). This exhibition room of Marker's works includes a movie theater and a museum where visitors discover a patchwork of still pictures, animated films and documentaries. This was the occasion for Frederick Thompson (aka Balthasar Truffaut) to virtually re-build the famous "La Jetée bar"(Tokyo) to offer a surprise to Chris Marker.

1.4. Virtual works characteristics and typology

An interesting feature of immersive platforms is that it offers to artists a field of expression and wider scope than the real world. Indeed, the physical constraints are no longer a limitation to creation: instead, artists can play and develop new types of reflection and creation. In the same way as a "traditional" museum it was necessary that we address the question of the work of art: what defines an art piece in these spaces? We concluded that three distinct conditions defined the status of artists in the immersive platforms. Thus, an artist is:

- A person with an artistic approach recognized by a community. This recognition is due to the profusion in time of its creations.
- A person recognized as a digital artist (using the new media). This category includes for example, Fred Forest, Yann Minh or Christine Webster.
- A recognized artist from another discipline and using this medium as a field of experimentation and creativity (Chris Marker, Thierry Mugler, etc.).

The plurality of works is not yet the subject of an extensive study on the artistic movements that might be present in these spaces. However, we have established a "typology" in order to show the diversity of artistic practices but also to point out existing problems encountered when making the choice to preserve and exhibit these works in a virtual museum. Thus, which forms will have these works? The creative field is large enough, we will list now the several forms of these works: we distinguish between real world art pieces and works implemented in virtual worlds, hyperformalist works, performances, speed build, the machinima (experimental movies made with a 3D video game engine), the works of mixed reality and performances.

2. The *Immaterial Art Stock* project

The *Immaterial Art Stock* project includes a virtual 3D modeled museum, housed in FrancoGrid and a website, listing the artists and works shown in the museum. The virtual art preservation mission consisted initially in referencing and establishing a state of the art practices since the inception of metaverses. This ongoing research, has led us found the abundance and richness of the works produced but also point to a numerous issues to resolve.

The principles and challenges of IAS museum does not differ from a "real" traditional museum: the *Immaterial Art Stock* missions are threefold: to preserve, document and disseminate. These three missions form the basis of the project lead us to think about the organization of the museum but also a conservation and exhibition protocol for virtual art.

2.1. The Immaterial Art Stock museum

The *Immaterial Art Stock* museum is hosted by FrancoGrid association, which provides a 65,000 meters square area space and no height limits. The architectural form of the museum (in levels) is closely related to the constraints and opportunities offered by these spaces: indeed, this form allows the museum to expand to infinity (in the limit of polygons and available servers capacity).

The museum is divided into several levels. The reception area of the museum, on the ground floor, consists of five sections: the first consists of an information center where visitor discover the artist biographies, studies and researches conducted on the subject previously. The visitor may also choose to be accompanied by a guide (in the form of a scripted object that communicates with its environment) in order to access to more complete contents. The second space is a media library in which visitor can see various videos (machinima, documentary, testimonials, etc.). The third area includes

three interactive screens that provide access to content available on the museum's website. The fourth area is made of several pictures giving an overview of works from the museum. By clicking on one of these the visitor is teleported into the artist space where he can observe and discover the artist work. This device allows him to understand the works and explore the museum in a less linear manner, by serendipity. The fifth area, the center of the ground floor, is main navigation tool, based on a "teleport" type: by clicking, visitor directly access areas of each artist work. Each floor hosts an artist. When the avatar teleports, he faces the artist's work, that he can spatially apprehend. For each work, he has the opportunity to consult the artist biography, the detailed cartel and Internet links referring to his artistic work. Also, this 3D immersive museum offers the possibility to the visitor to walk through and around the art piece. This is one the main point of our project, because we considered that web documentations and pictures are not enough to give a full experience with this type of pieces of art.

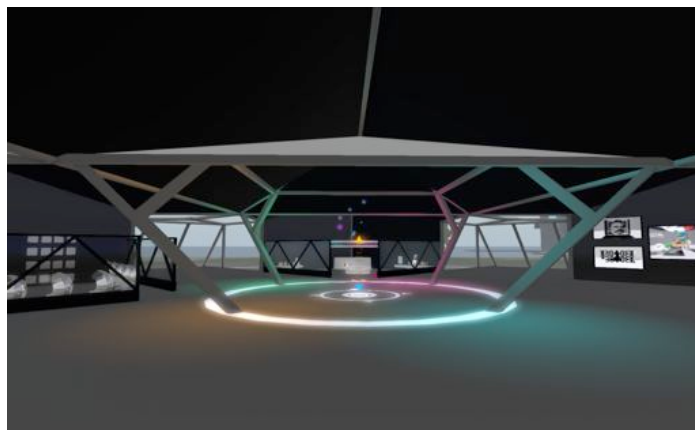


Figure 2. Reception area of the *Immaterial Art Stock* museum (screenshot)

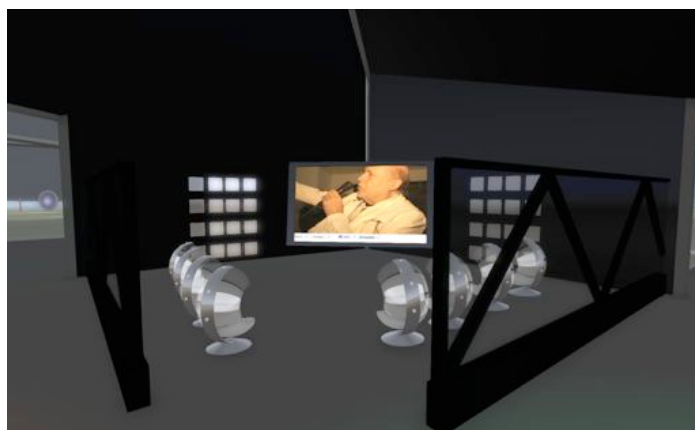


Figure 3. Media library of the *Immaterial Art Stock* museum (screenshot)

2.2. Conservation protocol

Following our field study, we felt it important to establish a protocol for the preservation and dissemination of virtual works of art. First, we have researched and referenced a number of existing practices in these areas (Second Life, OpenSim, etc.). This step is the subject of constant attention on new works. From this artistic watchfulness, we establish a built and durable contact with the artists. This contact and discussion are highly desirable: during this interview, we train them to tools to save their work, it also supplies documentation in relation to their approach, their past and future work. In addition, the artists met (Yann Minh, Christine Webster and Fred Forest) have all expressed the importance of such an approach to conservation and a long-term relation.

During this meeting, the work is moved from one platform to another (for now, we have moved works of Second Life to OpenSim).

This is the transfer protocol:

- Connection to Second Life virtual Platform (hosting the original art piece).
- Recovery of content as a TXML file: this is to retrieve the coordinates of each object in space.
- Disconnection from Second Life and connection to *Immaterial Art Stock* museum in OpenSim.
- Re-import content using the TXML file in the new area created for the artist.

The recovery of content can be done in three ways: the first, and probably most representative of the work, is to recontextualize the closest to his first enactment by including the interaction scripts, set and architecture surrounding sounds. The second is to recover part of the art piece: it does not offer a complete experience of the initial work but allows the viewer to apprehend at one point the state of the art piece. The third method, if we cannot find content, is to establish a textual, image and video testimonies.

Moreover, it is necessary to communicate about these actions: the website *Immaterial Stock Art* communicates on these initiatives and provides research articles, a regularly updated bibliography, some artist work documentations (these documents take many forms: artist biographies, descriptive works, theoretical articles, etc.).

2.3. Exhibition procedures

Art exhibitions in virtual worlds are quite common; there are several museums (e.g. Dresden Museum, the Tech Museum of Innovation, Musei di Roma Capitale, Second Louvre Museum), private collections (collection of Tatiana Solomon in the Green Island in Second Life), universities (Northwestern Michigan College, University of Texas at San Antonio) or artists (Christine Webster, Yann Minh, Fred Forest, Chris Marker, etc.) to exhibit their works in dedicated creation spaces. A considerable amount of literature has been published on classical museum installed in virtual words [4] [5].

However, an important distinction is to be noted in our museum approach. There are already many virtual museums that receive classical works of art from the “real

world". On the contrary, our approach is to collect only works of art created in the online immersive platforms. This approach is similar to *Aire Ville Spatiale*, "an artistic, social, architectural, humanist and digital creation space"[6] created by Marc Blieux (aka Marc Moana) and designed from a model of *La Ville Spatiale* (The Space City) designed by the architect Yona Friedman. This space exhibits many digital artists such as Christine Webster, Nathalie Fougeras or Elif Ayiter, etc.

What are the characteristics of a virtualized art experience? What are the optimal settings to appreciate these virtual exhibits? The works of art exhibit in *Immaterial Art Stock* museum, as discussed earlier, have not all the same exhibition conditions. Indeed, whether *Limbic* (topography sound work) by Christine Webster, or the *Artistic meters square* of Fred Forest or *Las Meninas Gallery* by Yann Minh, these works are protean. As for *Limbic*, the space exploration is essential, for the others, visitors can also navigate the art piece from anywhere around. It was therefore necessary, in the framework of our project, to reflect the scenography of these protean works, as they all have different way to appreciate them.

In order to enhance virtual works access, we should offer them the most appropriate form and space. Therefore, we multiply their access points. Thus, to offer the most valuable access to each work, we propose to use the following three elements: WEB-Virtual-Real. This approach allows the understanding of virtual works of art in different ways. The museum experience is therefore personalized and can be differently explored by each visitor. For example, a visitor can discover on our website a wealth of textual information on the work and the artist, accompanied by videos and images. Then, we invite our visitors to connect to our platform to an immersive experience where we redefine the work in a similar environment to the original. Immersive navigation allows visitors to share and interact with each other. Often, the term "virtual" is opposed to reality. Yet, we see an increased porosity between these two worlds that could be compared to an interpenetration layer. Specifically, there is no opposition between these spaces, on the contrary, they feed each other.

We could consider that immersive platforms are an in-between field of reality and virtuality. Finally, the third part of this triptych takes place in the tangible world, which then lets organizing different events such as exhibitions, encounters between artists and their audiences, workshops, video projections, etc.



Figure 4. *Las Meninas Gallery* by Yann Minh in the *Immaterial Art Stock* museum (screenshot)

3. Critical thinking and outlook

The conservation and exhibition of virtual work of art raises issues [7] [8] that will be studied in this chapter. Thus, the first problem is the obsolescence of the world which the museum is built; therefore, why keep a work of art in a virtual world, doomed to disappear, and return in another space with same constraints? Should we think the short-term conservation with evolving technology or otherwise, think of conservation techniques in the longer term?

3.1. Safeguarding actions

The digital art conservation is the subject of several studies and projects whose purpose is to consider the conservation problems of these new art forms [9] [10]. However, no institution has yet dealt with the problem of virtual art conservation. The *Immaterial Art Stock* initiative continues the work begun by the Foundation Langlois (Foundation for Art, science and technology museum) in Montreal and the Solomon R. New York's Guggenheim [11], with a focus on the virtual works of art. From 2001 to 2006, these two institutions have created the *Variable Media Network*: This project aimed to study the problem of technological obsolescence, to produce a typology of different forms of media arts and to develop conservation strategies that consist to observe these artistic practices involving several institutions. "The network share experiences, common method reflections, and developing common tools." [12].

Now, back on the concept of *Variable Media*: "The term used to designate *variable media* works for whose physicality is not fixed once and for all. [...] Each work is considered individually, more like a score than a finished object, immutable." [13] This conception of the work, thinking like a partition, out of its medium, which has the ability to update in a new space is fundamental to the preservation technique of I.A.S research project. Thus, instead of designing the work as a "finished product", it can be transposed and re updateable in some new spaces.

A second project, "Archiving the *Avant Garde*: Documenting and Preserving Variable Media Art" is the source of the research methodology for *Immaterial Art Stock* project. This initiative, conducted by the Berkeley Art Museum / Pacific Film Archive, which incorporates the concepts developed by the Langlois Foundation, is to "document and disseminate strategies for describing and preserving works that do not update the traditional way. It proposes to further develop the rating, cataloging and access to works in the collections". This initiative includes several museums and institutions in order to extend the conservation strategies and to think together on the issues raised by this action.

Immaterial Art Stock is not a "museum" in its strictest definition, but a presentation space and updating works, a "living archive" as described by Anne Laforet in her report *Net art and art institutions and museums, issues and conservation practices*: "The museum would be, to that effect, a living archive, a documentation space, with fragments of works that can be updated in many ways, and combine with inter-relational automatic archiving national aspect and a more qualitative and normalized museum." [14] The museum is thought both as an exhibition space and also as a critical and research space about virtual works of art.

3.2. Preliminary results and development prospects

How the *Immaterial art stock* research project can persist over the long term? Several perspectives are underway or planned to pursue conservation, exhibition and documentation activities.

The *Immaterial art stock* virtual museum intended to provide greater public access to the works created in online immersive spaces. As noted previously, there is still oftenly a certain ignorance and reluctance to explore these artistic spaces. Access to these technological platforms unfortunately restricts the visibility of artists and their works that we show. We have also chosen for our approach to globalize communication, aiming to offer to the public, various entry points in our museum. This communication takes different forms and then develops in several virtual locations, web or tangible.

The first concept to consider is the persistent aspect of these online immersive platforms. This feature leads us to constant maintenance and increased animation to support the museum. This, requires various actions such as facilitating access to information, an invest to optimizing the quality of information content through a frequently updated content (as the long-term support of artists seems primarily one of the foundation for sustaining the place). It would be important to expand the reach of the museum's website and on various media such as tablets or mobile phones.

In a second step, the animation of the virtual museum can also take different forms such as conferences, debates, exhibitions, art competitions (so that *Immaterial Art Stock* project could be a leading structure for the future of a virtual art creation) workshops, etc.

The third stage takes place in tangible spaces and involves institutions. We observed several institutions (such as *Gaite Lyrique*, *La Cantine*, the new media space of the *Centre Pompidou* in Paris or the multimedia *Gantner* space to Bourogne, to name a few) expose or enhance (through conferences, workshops or roundtables) works of digital art. We will aim to contact them to combine our different expertises on the subject. Indeed, it is now important to recontextualize the work in a space provided for this purpose. In this way, a novice public is invited to discover, in a formal setting, all these creations but also to meet the creators of these works and to exchange, share and discover with them. Moreover, the conservation of these fragile works has pushed us to preserve that kind of art, but that is only part of the reason. It seems fundamental to include these works in a process or an artistic history in the evolution of digital technology.

Finally, the last important aspect to develop this project comes from the heart of our research on EN-ER laboratory. New media offers opportunities to engage the visitor within both the virtual and physical museums. Indeed, the 3D, web, and immersive spaces will soon unit and be one. This offers the possibility to create a new medium easily accessible, with rich and highly interactive contents: for example, the advent of html5 introduced the ability for a webpage to host more qualitative 3D content. On the other hand, the evolution of our digital media (computers, tablets, phones) and the increasing capacity of the flow networks, allow us to imagine a future of immersive platforms easily accessible and aesthetic. Thereby, visitors will have an easier access to piece of art and information and this will allow the project to be considered in the longer term.

Links

1. *Immaterial Art Stock* museum location on FrancoGrid :
<http://slurl.com/secondlife/ENSADLAB%20ENER%20EXPO/132/117/22>
2. *Immaterial Art Stock*'s Website: <http://immaterialartstock.wordpress.com/>

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Learning Design and Structured Tasks in 3D Virtual World

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Abstract: E-Learning is one among the many positive implication of computer networking. It grew rapidly with the advent of World Wide Web. Soon many E-Learning paradigms flourished across the web. This resulted in the need for standardization, an effective guideline to make e-learning more structured and effective. The need for designing for learning resulted in many pedagogical models of which Learning Design has proved popular.

Many platforms such as Learning Management Systems (LMS) were soon inspired by Learning Design and a significant success is seen over the last decade by the education sector adopting such systems.

Also, the use of immersive environments like 3D virtual world has increased in the field of education. The scope and capabilities of these environments are interesting, so are the challenges associated in using them. The main problem for using these environments in education sector is the lack of ease with which authoring can be done in them. On the other hand, Learning Design engines such as LAMS offer much easier authoring in 2D.

This project proposes an approach to deploy the design sequence created in a 2D authoring interface such as LAMS into a 3D virtual world like Open Wonderland. The aim of the project is to ease the difficulty of authoring in 3D environment as well as a unique attempt to integrate Learning Design concepts into any virtual world.

Keywords: 3D virtual worlds, Education, Learning Design (LD), Authoring, Open Wonderland (OWL), LAMS.

1 Introduction

The growth of communication technology and the increasing importance for collaborative activities have made a significant impact on supporting Anytime, Anywhere Learning (AAL)[1]. Among various pedagogical models, IMS Learning design (LD) has played an important role in establishing a de facto standard for authoring the online learning processes. Learning Design emphasizes sequenced/structured set of learning tasks comprising of various Units of Learning (UoL) that can be shared and reused [1].

In the recent days, Learning Design (LD) inspired LMS (Learning Management Systems) like LAMS, Moodle, CopperCore, etc have evolved notably in offering the ease of authoring learning tasks in 2D, satisfying the specification of IMS-LD. The authored tasks from these engines are delivered using a 2D player such as EduBox[1], Flash based player in LAMS, etc

Amidst the evolution of LD engines and deliverables in 2D players, the use of immersive environments like virtual world has increased in the field of education [2]. The scope and capabilities of these environments are interesting, so are the challenges associated in using them.

The 3D virtual environment is an ideal platform to conduct collaborative tasks among people residing at various parts of the World [3]. The concept of Presence Pedagogy [3] uses the 3D virtual environment/Virtual World to describe various methodology by which collaborative tasks can be conducted.

The main problem for using these environments in education sector is the lack of ease with which authoring can be done in them. This sets up the context of this project. This project is an attempt to aggregate the robustness and ease of authoring in 2D with the capabilities that a 3D environment offers. In this regard, an approach based on the work we have done is described in this report. It is to deploy the task design (IMS-LD Units of Learning) sequence created in a 2D authoring interface such as LAMS into a 3D virtual world like Open Wonderland. To the best of our knowledge this work represents the first attempt of implementation to integrate LD into a virtual world.

The concept presented in this paper has a working system and thus the use of word 'project' is used at some places to refer to the work undertaken.

The words 3D virtual environment and virtual worlds used are interchangeable. OWL is an abbreviation for Open Wonderland that is used in the various sections of this report.

2 The idea in brief

The following is an attempt to pictorially represent the intended system/idea/approach to integrate IMS-LD in OWL.

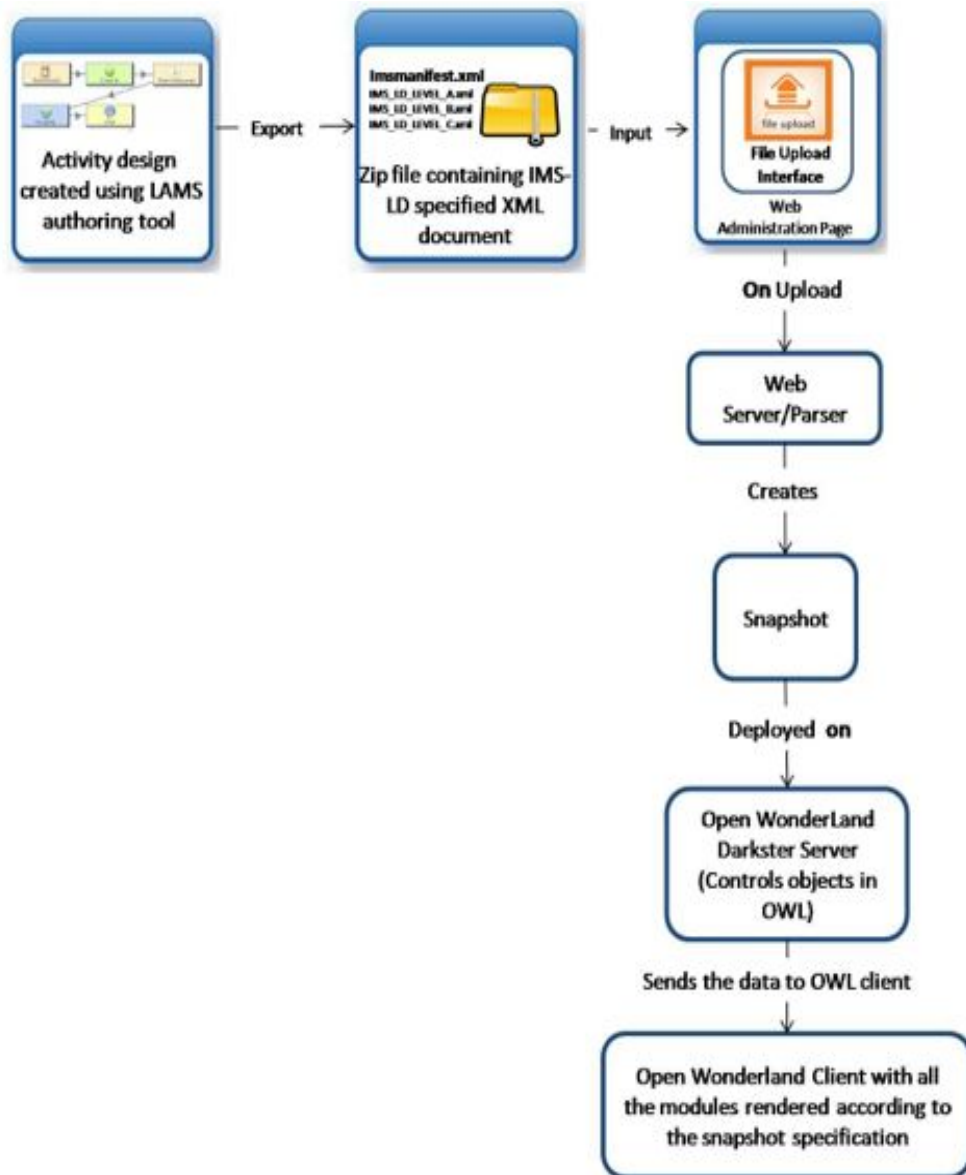


Figure 1: Pictorial representation/control flowchart of the project

The diagram explains most of the things including the flow of implementing IMS-LD Units of Learning (UoL) into OWL virtual environment. Each block represented in the above diagram is explained in detail in the upcoming sections

3 LAMS for authoring Units of Learning

Learning Activity Management System popularly known as LAMS is among the successful LD engines. It implements all the 3 levels of IMS-LD and facilitates designing, managing and delivering online collaborative learning activities. LAMS is inspired by the concepts and principles of IMS-LD [4] and has received Gold Award and the title for being the best learning system at IMS Global Learning Consortium's Learning Impact Awards [5].

The paper proposes a concept that uses the popular 2D authoring environment and transfers the design to 3D, thus eliminating the difficulty of authoring in 3D which is the primary goal of this paper. LAMS has a powerful authoring environment and also a reliable export feature thus making it the suitable choice over other LD engine such as CopperCore for the concept proposed in this paper.

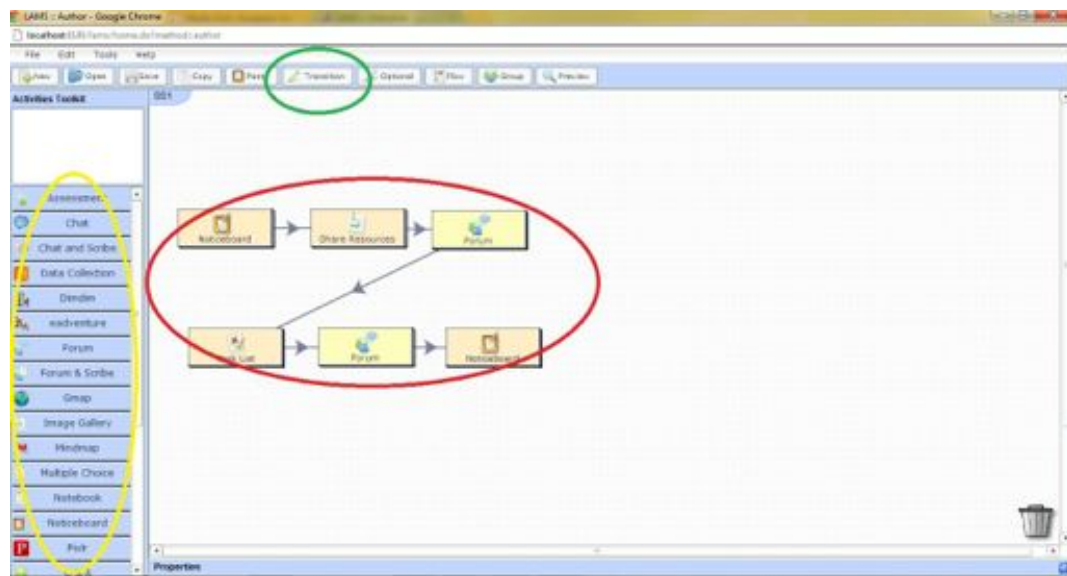


Figure 2: LAMS authoring environment with a design sequence

The core activities provided by LAMS that are used to create activity sequence are, Chat, Forum, Task List, Multiple Choice, Noticeboard, Q and A, Share Resources, Survey, Voting. These can be seen listed in the left panel in the above figure. The activities are dragged and dropped onto the canvas and then are sequenced using a transition tool from the tool bar at the top. The arrows between activities mark the activity flow. Double clicking on each activity allows the author to enter the data for that activity. For instance, a forum activity allows the author to write instructions for the learners as well as the topics to discuss.

Once an activity sequence is created involving a collection of activities with data and transitions as in figure 2, LAMS provides a facility to export the design to a IMS-LD level B [6] conforming XML document which is named as *imsmanifest.xml*. The xml file consists of the markup describing the content, order of each activity in the sequence. This document along with IMS-LD specifications of 3 LD levels [6] are downloaded in a single zip file. The zip file is the source for deploying Learning Design into Open Wonderland.

4 Learning Design in 3D Virtual Environment

4.1 Pedagogical Theories that support learning in 3D virtual world

The 3D virtual environments are characterized by their representational fidelity and learner interaction[7]. Representational Fidelity is about user representation, realistic display of environment, objects and their motion. Learner interaction refers to the verbal and non-verbal communication, navigation, and object manipulation. These characteristics result in the possibility of learner engagement. It is to be noted that, one of the core ideas behind LD as described in previous section is about learner engagement and it is interesting that 3D environments are good at offering it.

The learning capabilities of the 3D virtual environments have been harnessed in numerous occasions. The concept of ‘presence pedagogy’ [3] uses the 3D virtual environments to describe various methodology by which collaborative learning tasks have been conducted in AET ZONE, an environment used for education [3]. According to Wang [8] virtual world is used as the most attractive form of computer mediated communication (CMC) in higher education. Michelle Ryan identifies and evaluates the 16 ways in which Second Life (a 3D virtual world) can be used in pedagogical approaches and virtual assignments [9].

Kitelhult and Nelson in their research [10] found out that, in a classroom that uses a virtual world, 75% of students completed optional tasks for no credit while in a traditional classroom only 4% performed similar task despite the benefit of extra credit. All these works and research findings strengthens the argument towards the success of conducting learning process in 3D virtual world.

4.2 Open Wonderland and its scope for Integrating UoL

Open Wonderland (OWL) which started as Project Wonderland in 2007 at Sun Microsystems is an open source extensible toolkit to create 3D virtual worlds. 3D virtual worlds provide a great scope for collaboration. The project started with an aim to fulfill the business collaboration requirement and soon the scope broadened covering the field of education, medical, simulation, etc. [11]. The fact that OWL is highly extensible, uses java and is open source provides many possibilities in which the platform can be utilized. Many sectors can benefit from the scope the OWL offers. One such field is the education. OWL has been used extensively for various educational projects across the globe [7].

OWL has a feature called snapshot system. By virtue of this system, it allows the user to take a snapshot of the current world he’s working on. The snapshot is nothing but the creation of a collection of XML files mapped one each to all the objects present at that moment in OWL virtual environment. The XML files describe object’s characteristics such as location, orientation, content, etc. The user can then make use of this snapshot anytime in future to render the same world he was in at the time of taking snapshot.

This paper takes the reverse approach of the snapshot system. Instead of capturing the virtual environment of OWL in form of XML files, it creates a virtual environment using a set of files.

5 File Upload Interface & Parsing

It is discussed in section 3 that LAMS already has a feature to export the design created in its authoring environment to a XML file. But the point of interest is on how this XML document is deployed into OWL i.e. the design into 3D.

For this purpose a separate upload interface is created in the web administration page of OWL. The markup of a subpage 'Mange Worlds' is been appended with the code for an upload interface. The web administration page with Upload interface is shown in figure 3 below.

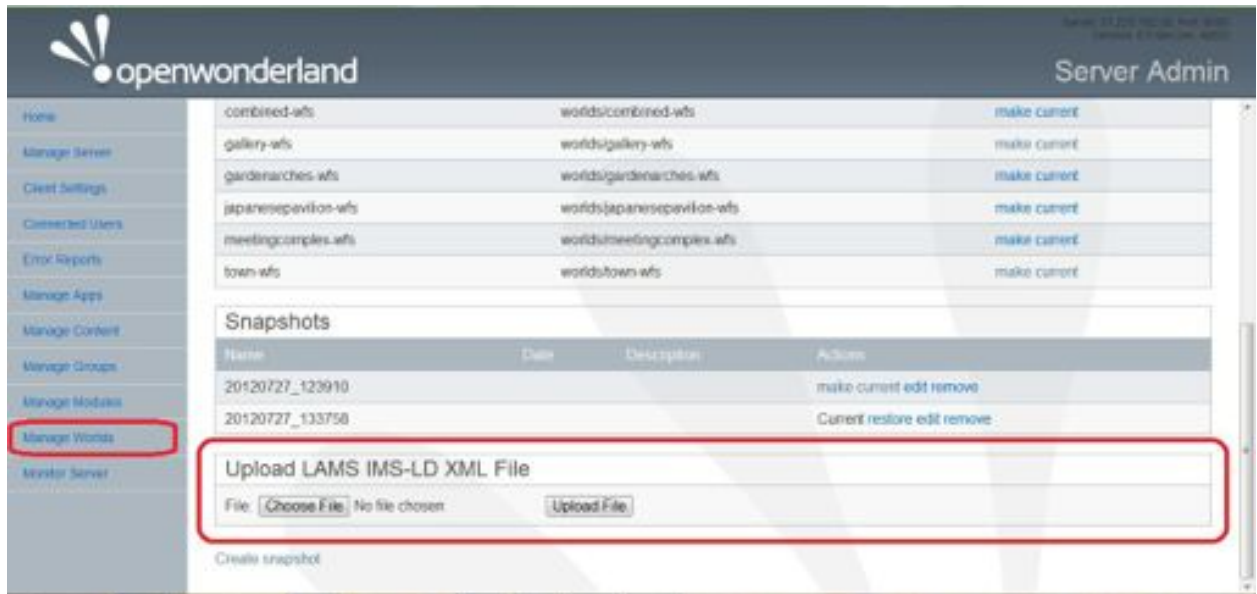


Figure 3: Snapshot of OWL Web administration Page with Upload Interface

The zip file that resulted after exporting design sequence in LAMS has to be chosen from the file browser window. Once the upload button is clicked, following is the list of activities that are run in the background.

- Zip file is uploaded onto the OWL Server
- Then it is unzipped and the imsmanifest.xml file is given as an input to an xml parsing code.
- Xml Parsing code designed for this project parses the imsmanifest.xml file and suitably map the activities of LAMS into OWL.
- During parsing, the reverse snapshot idea proposed by this project is executed by creating multiple xml files for the objects in OWL to support the mapping. Once all the files are created it is bundled as a snapshot and deployed on server.
- The snapshot on deployment by the user presents the activities designed in LAMS in a 3D OWL virtual environment maintaining the sequence as well.

6 Mapping, Placement & Sequencing the activities in OWL

6.1 Mapping of LAMS activities into OWL

The core activities of LAMS are mapped according to the Table 1.

Table 1: Mapping of LAMS activities to OWL modules

LAMS Activities	Mapping in OWL
Forum	Forum Area: A gallery cell, with topic of discussion using a sticky note/HTML Poster. Comments using blank sticky notes or statement wall cell [12]
Share resources	A room with sticky notes with Web-links, recorder and video player
Chat	An area dedicated as chat area where text chat can be done using chat window of OWL and voice chat using voice bridge server. Voice chat can also be recorded using recorder.
Task List	Task area with task sticky notes and statement wall [12]
Voting	Polling cell [12]
Notice Board	Sticky Note/HTML poster
MCQ, Q&A, Survey	Pending to be mapped.

The MCQ, Q&A and Survey activities are similar in nature and are assessment type of activities. Thus the approach to map these activities is a bit different. Diego, Carlos and others in their paper “Assessment in 3D Virtual World : QTI in Wonderland” [13] propose a challenging yet possible approach to help mapping these activities. This becomes a major work for future enhancement for this project.

6.2 Placement of OWL modules representing LAMS activities

A predefined world is defined to hold the optimum number of LAMS activities in a predefined location. During parsing of xml file, each LAMS activity renders the corresponding module in the predefined position in OWL. If the parsing function doesn't encounter a particular lams-activity in xml, then it doesn't render its corresponding module in OWL.

The layout of predefined world for this project is presented in figure 4.

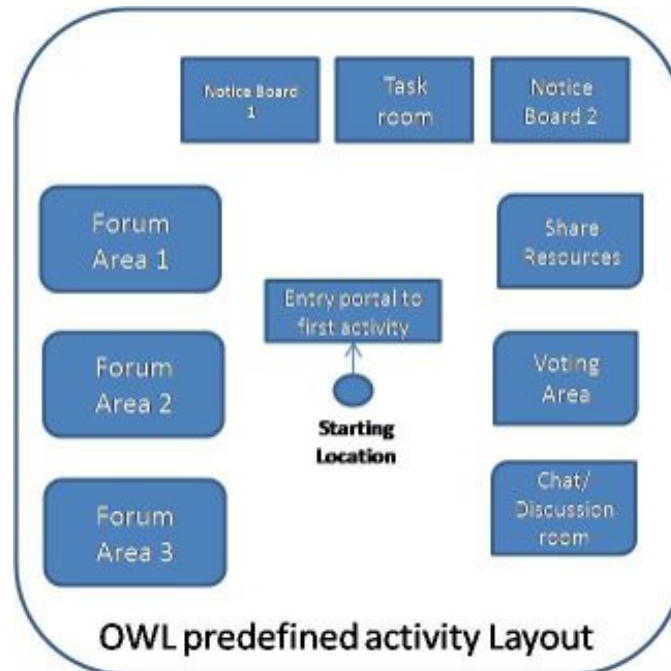


Figure 4: OWL predefined activity layout

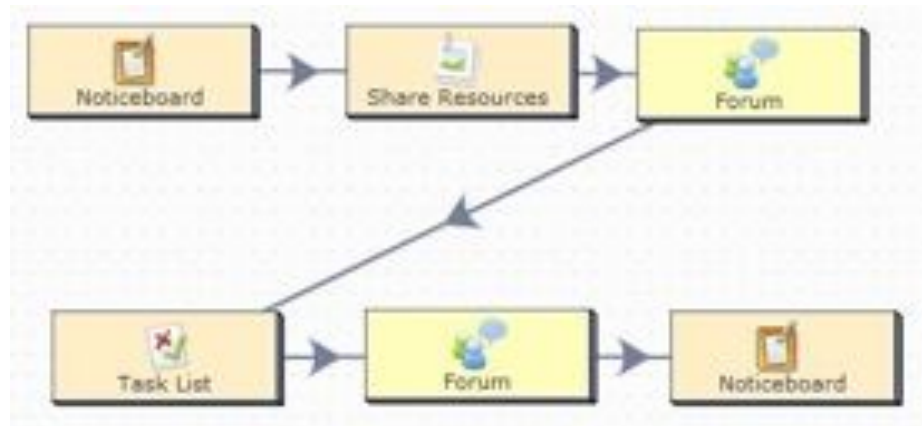


Figure 5: Snapshot of OWL Web administration Page

If the lams activity consist of a sequence as in the figure 5 which consist of 2 forum activities, then it makes sure that out of 3 forum areas in figure 4, only 2 are rendered.

It is directly evident that this approach exposes a limitation on multiple number of a same activity. But at this point, this limitation is assumed to be trivial and is proposed for further enhancement.

6.3 Maintaining the sequence of activities

Each activity is identified with an activity identifier in the `imsmanifest.xml` file. The activities identifier appears in order. This data is used by the parser to sequence the activities in OWL.

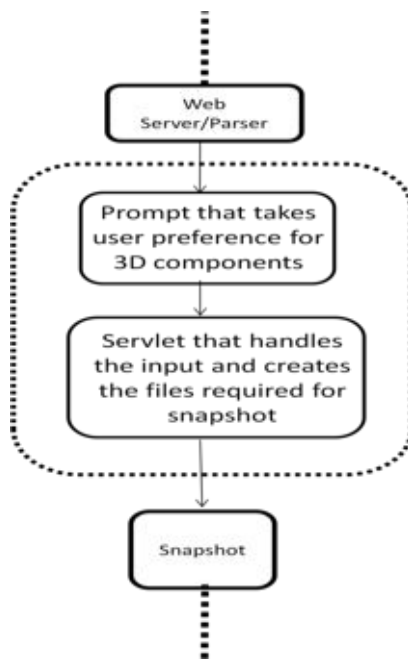
The transition from one activity to another is governed by OWL portal modules holding the location coordinates of the next activity. The capabilities feature of the container holding a particular activity will not let the learner to move outside the container without completing it.

7 Future Work

Though the project claims a working system, it is still in its initial version. During the implementation of this project, various new and interesting challenges are explored. The project has mapped a few tasks of 2D in LAMS to 3D and remaining are to be mapped.

The domain of assessment has to be implemented yet and a paper by Diego & others[13] provides a probable guideline for it.

Currently the rendering of 3D space for the designed 2D activities is limited to a predefined design and number posing it to be more static. This can be made dynamic and the author of the learning activities can be provided the freedom of choosing the required 3D components for the learning activity. Technically this modification can be realized by modifying figure 1 as follows:



The wonderland module warehouse is continuously growing and thus the tasks can be remapped with more productive modules. One such instance is emphasized in the project i.e. the use of statement wall instead of blank sticky notes to collect the opinions. A plan to work on the creation of modules that may be more productive in mapping tasks can also be undertaken as part of this project.

8 Snapshots of the project in action

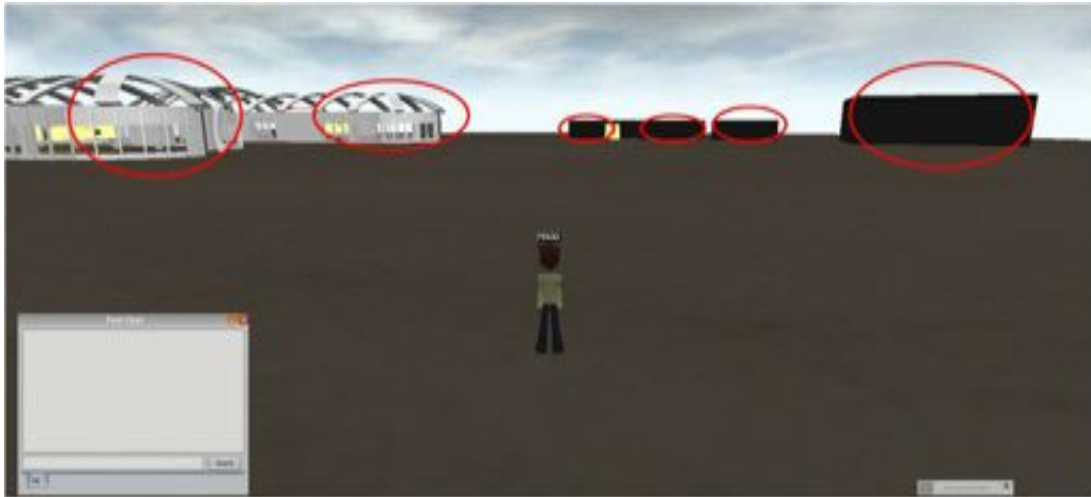


Figure 6: Rendered activities in OWL corresponding to LAMS activity sequence

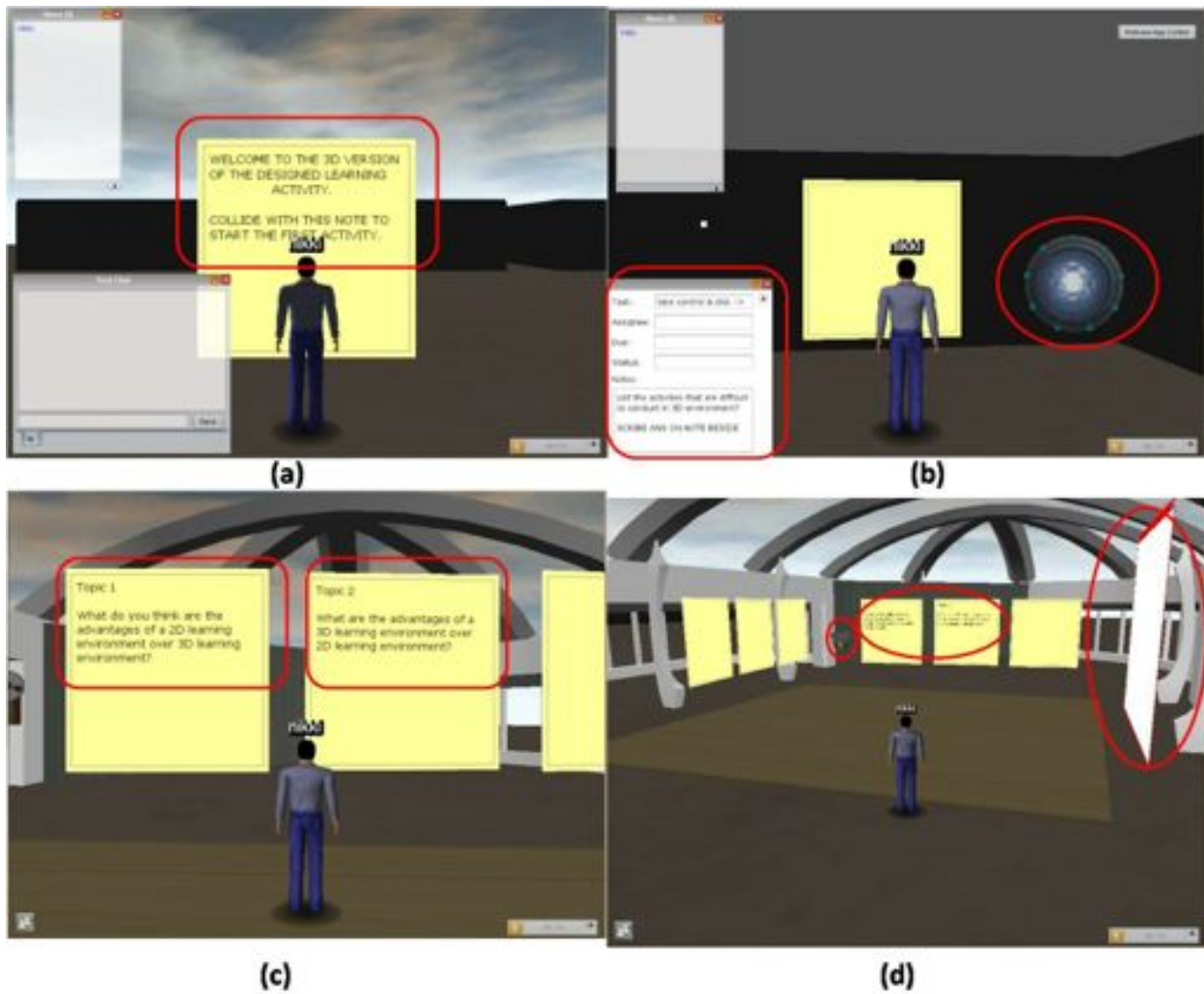


Figure 7: (a) Starting point in OWL (b) Task activity & portal (c) Forum activity (d) Forum area

The implementation details described so far, finally leads to this section which is intended to demonstrate the system in action. Figure 6 shows all the modules that are rendered when the `imsmanifest.xml` representing the sequence in figure 5 is uploaded. The 2 forum activities are rendered as 2 gallery modules in the left and other activities are rendered as different rooms as shown. Note the placement of modules matching to the layout in figure 4.

Figure 7 shows different learning activities that are mapped to the ones designed in LAMS.

Section (a) in the figure 7 shows the point where the user starts when he enters OWL. A generic note with a welcome message is displayed at the start. The welcome note also acts as a portal, thus on colliding takes the user to the first activity. Section (b) shows how the task list activity is mapped. As described in Table 1, a task sticky note is used and its HUD control is highlighted at the bottom left. The portal cells as the one marked towards right is used in each activity area to move to the next activity. Section (c) demonstrates how, the topics of a forum activity designed in LAMS are captured on sticky notes in OWL. Finally section (d) is a chase camera view of the forum area which has sticky notes containing the topics of discussion, blank sticky notes (which can be replaced by a statement wall [8]) to scribe the opinions, whiteboard for any brainstorming and also a recorder to record the discussion.

9 Conclusion

The project is unique of its kind and hence needs an extensive evaluation both in terms of technical and user evaluation. The evaluation trials are planned and yet to be completed by the time this paper is submitted. User evaluation of this project is expected to give out an important finding whether learning activities (IMS-LD specification) in 3D provides more effective learning space than 2D. The project also acts as a test case to verify learning affordances of 3D virtual worlds in general[7].

The other aspect that is interesting in this project is that, it unveils a new approach to build objects in a virtual world i.e., from a raw xml data than practically creating objects within the virtual world. Though such an attempt has been made previously with PIVOTE project [14], but it was not based on LD.

Further enhancements proposed at various sections of this paper are the next things on the agenda to work on and reach a point where this project can practically act as an adapter to any 2D LD authoring environments to the open wonderland virtual world.

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Using Immersive Virtual Environments to Promote Creative Scientific Problem-solving: the *SAVE Science* Project

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Abstract. *Situated Assessment using Virtual Environments for Science Content and Inquiry, SAVE Science*, is an NSF-funded study developing an innovative system for contextualized, authentic assessment of learning in science. In *SAVE Science*, we are creating, implementing, and evaluating a series of immersive virtual environment-based modules for assessing both science content and inquiry in the middle grades. The modules are designed to enable students to perform a series of assessment tasks that provide data about how well they have mastered and can apply content knowledge and inquiry skills taught via their regular classroom curricula. Multiple pathways are supported. This demonstration will show one module and then allow participants to explore a second with time for discussion at the end.

Keywords. Virtual environment, Assessment, Science

Introduction

Bruce Alberts, Editor-in-chief of *Science* magazine, has written a series of editorials outlining his concerns over the state of science education. In one editorial of particular interest to this proposal, he states that, “Doing good science is a highly creative endeavor, much like producing a piece of art” (April 13, 2012). Continuing the analogy, he states that a scientist chooses tools that are appropriate to the problem to be investigated, which is similar to an artist deciding on the medium that will best portray the subject to be explored. Further, scientists and artists must both decide on a strategy for the investigation/design that should include knowing what exists and what is yet to be created.

If this is an appropriate description for what a scientist does, it is no wonder that Alberts has in the past worried over the state of K-12 science education. In an earlier editorial (January 20, 2012), he condemns much of pre-college science education as a place where students “are taught with an overly strict attention to rules, procedure, and rote memorization.” It is hard to understand how such a beginning could ever result in such a wondrously-described scientist. While there are many reasons for the current state of pre-college science education, there is little doubt that the current emphasis in the United States and other countries on standardized assessments as guide to pedagogical and curricular excellence is partially at fault. The National Research

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Council [1] in the United States suggests that tests should reflect the complexity that is science. Unfortunately, the current climate in the United States puts the burden of assessment on standardized tests which do not reflect this complexity. Students are more often assessed on whether they understand terms such as “hypothesis” or “control,” but in-depth assessment of their abilities to formulate questions and hypotheses, and design and analyze experiments, is often neglected [2]. Further, since teachers are assessed by how well their students do on these tests, they appropriately feel obliged to “teach to the test.” Designing new assessments which encourage good pedagogy is crucial if the current state of affairs that Alberts bemoans is to change. This demonstration proposes to involve participants in a demonstration of such an assessment, *Situated Assessment using Virtual Environments for Science Content and Inquiry (SAVE Science)*, that offers students multiple pathways to solve science content-based problems while employing inquiry skills.

In *SAVE Science*, we are creating, implementing, and evaluating a series of digital game-based modules for assessing both science content and inquiry in the middle grades (ages 11-14 years). The modules, based in an immersive virtual environment (IVE), are designed to enable students to perform a series of assessment tasks that provide data about how well they have mastered and can apply content knowledge and inquiry skills taught via their regular classroom curricula. To simulate authentic science, there are multiple pathways students can use to investigate the problem. IVEs are particularly well-suited to that design and their immersiveness encourages students to engage with the problem. Further, IVEs allow complex and dense datastreams to be collected for each student that can be analyzed to produce meaningful and accurate inferences about student learning. These analyses provide additional insights about student understanding beyond what is possible from more traditional assessments while also being far more engaging for students.

In this proposed demonstration, I will first show the “basketball” assessment module (Figure 1). The main purpose of the basketball module is to assess students’ knowledge of gas laws and related properties as well as aspects of scientific inquiry. In this module, students are asked to help Julius, the manager of a local basketball tournament, find out why basketballs are not bouncing well at the outdoor tournament court, while identical balls are functioning properly at the indoor court in the local gymnasium. To investigate this problem, students can interact with various characters from the outdoor and indoor courts to obtain information about conditions at each environment. Also, students can gather information about objects found at each court (basketballs and balloons) using a number of SciTools such as pressure gauges, scales, and tape measures. To support scientific investigations within the module, students can pick up and carry basketballs and balloons in a personal backpack between the outdoor and indoor basketball courts to observe and test any changes in the measurements when the objects are exposed to different environmental conditions. Only a subset of these actions is needed to solve this problem, and I will show the many different paths available.



Figure 1. "Basketball" assessment module



Figure 2. "Weather" assessment module

Following this, participants will be given access to the "weather" assessment module (Figure 2). This module is designed to assess weather concepts such as air masses, fronts, and precipitation. Scientopolis is in the midst of a severe drought; crops are dying and animals are starving. Because the town's people believe the town is jinxed, they are packing up to leave. Farmer Brown, who has lived in the area his whole life and does not want to depart, tasks students with a mission to save his town by finding a scientific explanation for the drought and predicting when it might end. In order to accomplish this, students collect data about the weather from several locations and sources. Students use their SciTools to measure wind direction, barometric pressure, and temperature and then compare these measurements through the graph or notes tools. Further, students can interact with various characters and artifacts to obtain information about previous weather conditions, in order to discover weather patterns. Once participants have had time to explore "weather," a discussion will be facilitated about the various approaches participants used in solving "weather." Following this, a group discussion will ensue on the impact such an assessment might have on encouraging creative, open-ended thinking in students.

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Embedding Augmented Reality Experiences in E-books

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Abstract. E-books marketplace is evolving faster than ever. New devices and technologies are coming into scene almost every month. In this paper we are going to review the main devices available for e-book publishing and rendering and their associated formats, with special attention to the EPUB3 format, which is called to be adopted as the standard for the industry. We will explain the new possibilities offered by this specification, with special focus on the scripting capabilities that will allow to implement augmented reality (AR) experiences inside e-books. We demonstrate also how to embed this AR experiences in the e-book thanks to new javascript libraries.

Keywords: Augmented Reality; e-books; EPUB3; Radium

1 Introduction

E-books marketplace is evolving faster than ever. We see new devices and technologies appear into market very quickly, showing new capabilities in order to make e-books more attractive to potential readers.

The first e-readers started to gain attention few years ago. Kindle¹, from Amazon, was the e-reader that revolutionized the market. But these first devices offered almost the same characteristics as a paper book, with few little improvements. Maybe an integrated dictionary and the possibility to search a word through the text. With this short capabilities, the possibility to create new content by users to enrich the e-book was scarce and thus their adoption by educational sector.

Nowadays, e-books technologies have evolved towards a more dynamic and multimedia experience. The new EPUB3 specification[1] offers the possibility to embed audio, video and multimedia animations into the e-book in a standard fashion. This specification offers also the possibility to write scripts using well known technologies (javascript), which opens the door to interactivity and content creation inside the e-book. Another capability specified by EPUB3 is the TTS (Text-to-Speech) feature, which allows e-books to become more accesible for blind people.

¹ <http://www.amazon.com/kindle>

In this paper we are going to review the main e-reader devices and technologies, showing their main features and weaknesses to be adopted by educational sector as a key tool for the learning process. We will show also how the new specifications (mainly EPUB3) can serve to create immersive e-books thanks to scripting, which allow the inclusion of augmented reality[2] experiences. The inclusion of this technology in e-books can have a direct impact on students behavior, making the learning process more engaging and motivating, as stated in[3].

Our intention is to include the AR experiences inside an e-book that could be used by students to learn not only the theoretical aspects of a subject, but also do practice thanks to AR exercises. We aim to create a new way for learners to face the learning process, doing it more attractive and complete thanks to these developments. This conception of the e-book as a whole, which includes both theory and engaging exercises with AR, fits well with the concept of Situated Learning[4], designed to bridge the gap between the theoretical learning in the formal instruction of the classroom and the real-life application of the knowledge in the work environment.

The paper is organized as follows: In section 2 we present the main e-reader devices and their associated characteristics. Section 3 will show the potential of EPUB3 specification to create AR experiences inside e-books. Conclusions and future work will be depicted in section 4.

2 E-reader devices and formats

From the beginning of e-books, many technologies and devices have appeared. Some of them have never gained users attention, while others have become top-seller worldwide. Nowadays we are seeing that multimedia tablets (e.g. iPad, Kindle Fire, etc.) are winning the match against dedicated e-readers, maybe due to their capacity not only to render e-books but also to run other 3rd-party apps.

In education, and for the purpose of this study where we want to introduce AR in e-books, we are going to center our attention only in multimedia tablets due to the possibilities that these kind of devices offer to present richer content to users. In order to be able to deploy AR experiences in e-books, we need that the devices meet some characteristics, including the ability to play multimedia content, support for open source specifications for e-book publishing like EPUB3, and of course the presence of a camera to capture the real world image.

Among the most remarkable devices we can mention the following:

- **iPad**. The iPad is a multimedia tablet launched by Apple first time in January 2010. Since then, two new versions of the device have appeared in a yearly basis. Among its main features, we can mention the ability to render multimedia e-books thanks to iBooks² app. This app allows to read digital books enhanced with audio, video and animations. The supported e-book formats by iBooks are ePub and PDF. As of version 2.0, iBooks also supports

² <http://itunes.apple.com/en/app/ibooks/id364709193?mt=8>

a proprietary iBook format (IBA), which is based in ePub but with some proprietary modifications which make it not fully compatible with EPUB3 specification.

- **Kindle Fire.** Kindle Fire is a multimedia tablet which runs Android as operating system. This tablet allows not only to read e-books but also to run thousands of apps developed for Android platform. Regarding e-books, the Kindle Fire doesn't support EPUB3 spec. Content formats supported are Kindle Format 8 (KF8) and Kindle Mobi (.azw).
- **NOOK Tablet.** The Nook Tablet is a tablet computer sold by Barnes & Noble, and is intended to compete with both e-book readers and tablets. It supports multiple file formats, including ePub, but not the new specification EPUB3.
- **Nexus 7.** The Nexus 7 is a 7-inch tablet, primarily competing with similar devices such as the Kindle Fire. The Nexus 7 shipped with the latest version of Android, 4.1, and with Chrome as its web browser. For the purpose of reading e-books, you can choose any app available in the Google Play Store for that purpose, which means that file formats supported are app dependant.
- **Samsung Galaxy Tab.** The Samsung Galaxy Tab is an Android-based tablet computer produced by Samsung. Regarding e-books, the behaviour is the same as for Nexus 7: you can install any app available for that purpose.

One critical aspect that is absolutely necessary when trying to develop e-books with AR is the presence of a camera to capture the image of the real world. From the devices listed above, only iPad and Samsung Galaxy Tab come with rear-facing camera. Nexus 7 has only a front-facing camera, which is not suitable for AR applications. None of NOOK or Kindle Fire come with camera integrated.

For our purpose, apart from the rear-facing camera, we need devices that can render e-books defined following the EPUB3 specification. EPUB3 is the only file format specification for e-books that allows the use of sophisticated scripts and is not proprietary. The use of some kind of code inside the e-book (in our case, the use of scripts) is completely necessary to develop AR applications with some kind of interaction between the user and the e-book.

Taking these considerations into account, the only available device to accomplish the objective of integrating AR functionality into e-books would be the Samsung Galaxy Tab.

3 Augmented Reality in e-books with EPUB3

EPUB3 specification was approved by the International Digital Publishing Forum (IDPF)[5] membership as a final Recommended Specification effective October 11, 2011. Due to the fact that it is a very new specification, there are hardly any implementations out there.

3.1 Radium Project and EPUB3

None of the devices analyzed above has native support for EPUB3 e-books, although an app providing that support could be installed in some of them. Among the few implementations of EPUB3 that we have found, one of them has caught our attention above all others. That implementation is called Radium[6].

Radium, a project of the IDPF and supporters, is an open source reference system and rendering engine for ePub publications. The latest version, EPUB3, is based on Web Standard technologies such as HTML5, CSS, JavaScript, SVG, and the DOM. The overall aim of the Radium project, as stated by themselves, is “to ensure that open source software for handling EPUB3 publications is readily available, to accelerate adoption of EPUB3 as the universal, accessible, global digital publishing format”.

Radium project is still in a very early stage. The first outcome from the project developments is an initial beta release of an extension that adds EPUB3 support to Google Chrome browser. This extension is far from providing full support for all the EPUB3 specifications, but serves as a proof-of-concept prototype.

Recently Google has released their Chrome browser, currently in beta, on Android[7]. These are good news for the purpose of having AR enhanced e-books in e-reader like devices. This way, installing the extension provided by Radium project in the Chrome browser of a tablet running Android (in our case the Samsung Galaxy Tab), we are able to render EPUB3 e-books in an e-reader like device.

3.2 How to embed AR experiences in e-books with EPUB3

As we have mention before, EPUB3 specification allows to include javascript code in the e-books definition. This fact opens the door to a new world of possibilities for interaction with e-books. With javascript we can create complex animations and sophisticated interactions, making the e-book more attractive for students and readers in general.

To create AR experiences, the first thing we need is to gain access to the device’s camera. Once we have the real world image in a frame of our e-book, we can superimpose 3D models and animations to create the AR experience.

In order to gain access to the device’s camera, javascript provides a new experimental API[8]:

```
navigator.getUserMedia()
```

which allows web apps to access a user’s camera and microphone.

With *navigator.getUserMedia()*, we can finally tap into webcam and microphone input without a plugin. But this is still a very new API and in some browsers may not be yet implemented. We have found that in Chrome < 21, you need to enable the feature by visiting *about:flags*. Chrome 21+, Opera and Firefox do not need a flag.

So, the first thing we need to assure is the existence of *navigator.getUserMedia* in the browser:

```
function hasGetUserMedia() {
    return !(navigator.getUserMedia || navigator.webkitGetUserMedia ||
            navigator.mozGetUserMedia || navigator.msGetUserMedia);
}

if (hasGetUserMedia()) {
    // Good to go!
} else {
    alert('getUserMedia() is not supported in your browser');
}
```

An example of how to include a functional code in our e-book to gain access to a stream containing the real world image could be the following:

```
<video autoplay></video>

<script>
var onFailSoHard = function(e) {
    console.log('Access to media stream rejected!', e);
};

window.URL = window.URL || window.webkitURL;
navigator.getUserMedia = navigator.getUserMedia || navigator.webkitGetUserMedia ||
    navigator.mozGetUserMedia || navigator.msGetUserMedia;

var video = document.querySelector('video');

if (navigator.getUserMedia) {
    navigator.getUserMedia({audio: true, video: true}, function(stream) {
        video.src = window.URL.createObjectURL(stream);
    }, onFailSoHard);
} else {
    video.src = 'somevideo.webm'; // fallback.
}
</script>
```

At this point, we have a stream contained in *video.src*, which can be analyzed to find patterns and markers that indicate where to superimpose the 3D objects and animations that will conform the AR scene. We are using JSARToolKit[9] in order to find and trace these markers.

4 Conclusions and Future Work

In this paper we have shown how to embed AR experiences in e-books using open source technologies and standards, so anyone can benefit from it. We have demonstrated how combining new javascript APIs with EPUB3 specification and e-reader devices can bring all together a new and exciting way to attract and motivate students when using e-books for educational purposes.

Technologies presented here are still in a very immature stage. For example, Radium does not implement all the features defined by EPUB3, but is expected to do it in the following months. Another drawback that needs to be solved in the near future is the use of Google Chrome browser for Android, which is also very unstable. We hope that these technologies evolve fast enough to be able to have real AR experiences embedded in e-books soon.

By the moment, we have implemented a proof-of-concept to demonstrate that AR experiences are possible inside a web browser. We have developed an e-book for Radium that contains a script to access the webcam. We have used

Chrome browser for Windows in a desktop PC. The next step is trying to develop the same prototype in a Samsung Galaxy Tab tablet with Chrome for Android, modifying the Radium extension if necessary to make it runnable in this browser.

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Education in 3D Virtual Learning Environment – Case Virtual-Mustiala

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Abstract. This paper discusses the use of 3D technology in education. We present the realXtend 3D technology available nowadays and directions of its development in the future. We introduce 3D learning environment, a Virtual-Mustiala, as case example and discuss its development work. The Virtual-Mustiala is extendable learning environment for training and learning. We describe its general functionality and one specific learning module based on authentic learning situation. This module can be applied to the other areas connected with education and training. In technology point of view we focus on the realXtend 3D open-source technology and compare its features to the other technologies and similar educational learning environments. We have tested the environment and learning module with the real users and describe our first findings. The paper concludes by calling for future studies and development in order to enrich learning processes and experiences.

Keywords. 21st century learning, 3D virtual learning environment, education, open source, training, vocational education

Introduction

The use of mobile, ubiquitous and virtual learning environment technology and digital content have provided new additional value to previous e-learning environments and learning process. Tools for collaborative learning, inquiry learning, and phenomenon based learning which will support new kind of visualization and guidance, emotions and learning regulation are under development. Still, learning has a role of social activity, and social interactions are important in virtual learning situations. Discussions and argumentations can lead into more profound learning results. Learning environments and modules need to be developed so that they supports learners to be more self-guided, self-directed and which helps them to control their cognitive learning process. Self-regulated learning (SRL) and meta-cognitive skills become more and more essential in future computer supported collaborative learning environment development work [14]. From traditional classroom type of learning environment we are moving towards game-like learning environments, simulations and learning modules where learning and knowledge retention happens. Into the future virtual learning environments we should develop tools (agents) that help the learner in thinking and learning process. [21]

There is a large variation of different kinds of virtual learning environments [4] [19][20]. However, traditional Internet based two dimensional (2D) environments are not enough to meet future challenges in terms of open, mobile and immersive learning.

More recently developed virtual learning environments have turned the approach towards three dimensional (3D) learning spaces, virtual 3D worlds [7][8][10][12][19]. Learning can be more motivating and interaction with the 3D environments or objects can enhance a learning experience when compared to the real life learning situation. [2][23][24] 3D virtual worlds have been studied for a number of years as an e-learning environment, primarily by higher education facilities [9][11][13]. However, there are still lacks in usability and user experience issues. Therefore, more studies need to be carried out in order to improve the user interaction through 3D objects and spaces.

In this paper, we introduce Virtual-Mustiala environment. This learning environment is developed based on the realXtend platform [1][15]. The realXtend engine was chosen as it allows easy content creation, modification to the world and content ownership. We discuss its technical development from education point of view and present how users have experienced this environment based to first release. The chapter 2 discusses the changes in learning and social cultures, but also in digital operational culture and tools. Chapters 3 and 4 introduce case study and discuss the benefits of 3D virtual learning environments. Finally the conclusion and future work are presented.

1. Background and motivation

1.1. 3D Technology as a driver for change

21st century has brought us rapid technology changes. 3D technology comes from the research laboratories to the home computers and towards tablets and smart phones. While our children are familiar with the latest technology and development in society, at the same time teachers and schools are not ready to utilize fully technology potential in connection with the new pedagogical theories. They lack technological, but even more importantly pedagogical experience to use new environments. There is requirement to build new working skills and methods together with students to be utilized in teaching and learning. Technology enables global learning and social communication through virtual networks and tools. Learners should be enabled to use their own devices to work with information and build their knowledge. But this is not the reality in learning institutes or schools nowadays.

Even today we do not have exact definition for virtual worlds. Researchers and experts have used the term according to their needs. Common understanding for the technology and standards would help us understand the phenomenon better [4]. If you search for example virtual world definition, you get colorful variation of different technologies from e-learning environments up to massive on-line games. Bartle [4] summarized virtual world as permanent places which exists in virtual reality, although users are not logged in. Virtual worlds have been developed from single spaces to large 3D spaces and term 3D world describes this development. Users and networks in virtual worlds are global. In the virtual world user is represented by its personal avatar. Avatar is autonomous, executing the operation defined by the real user. Tools like chat or voice are helping communication in virtual worlds and gives possibility to participate the common actions. In virtual world a user has possibility to plan his/her own spaces and learning tasks. [7][8]

Virtual world is a place in Internet, where the user can work ubiquitously. If the user is online, the actions are visible real-time. On the other hand, if you are not connected to the world, you can see the changes later on. Virtual worlds are under constant development and change.

Virtual *learning* environment are defined unclear and definition is depending from the person. Virtual learning can vary from distance learning to e-learning environments. In general, virtual learning environment is the place which connects the users into discussion areas, group working tools, guidance, learning tasks, material and other links. From distance learning and e- or m- learning technologies researchers are more and more moving towards 3D and virtual worlds like Second life, open wonderland and realXtend. [7][8][11]

Dickey gives examples from virtual worlds, which supports constructivist learning and works as participatory learning environment. [7] Bares et al. [2] researched task related learning, where you move with avatar and carry out the problems you are facing. By doing you actually learn and this kind of learning is more motivational and entertaining. [2] Also Yair [24] points out the fact that in 3D worlds we are able to research phenomenon and authentic learning problems, like space and solar system, which we are not able to reach in real life. This makes learning more meaningful. [24] Zhang et al. [23] present the idea of virtual world made for certain purpose, like museum environment and exhibition. By using this kind of virtual world the user have the possibility to explore, see and listen the historical data. This kind of 3D virtual learning environment (3DVLE) supports and helps learning. Virtual 3D learning environment gives the learner possibility to learn by doing and in interaction with other learners, sharing and reflecting the experiences, when learning itself become more convenient. [23]

1.2. New learning models and change of working culture

Virtual 3D learning environments have constructivist learning paradigm, in which the world itself improve communication and authentic problem solving among students. We based our approach on socio-constructivism pedagogical theory and the basic problem in Education, which is between the group approach in educational process and the individual way how learner builds its knowledge. Constructivism theory states that the knowledge is not transferable. We can transmit information only but the knowledge is constructed in learner's brain through experience and active participation. These constructions are individual. [11]

On the other hand one of the biggest benefits in virtual worlds is that those enable real-time communication together with realistic visual environment and support collaboration. In 3D virtual worlds learners students can apply skills they have learned together with multidimensional environment. By using this kind of environments, students can have a look at certain phenomenon from different point of views and if necessary also game-like. From learning point of view, in virtual 3D learning environments, you can explore and change things without the effect into real world. The student is able to learn by doing. [7]

These kinds of learning situations are able to utilize in classroom learning or in distance learning. In distance learning the distance between learners is remarkable longer and that's why the social skills and abilities are highlighted more by using virtual worlds.

1.3. Teaching and learning environments in vocational education and training

Multidisciplinary professional training requires a variety of learning environments. Finnish education providers can be seen as pioneers in introducing new learning environments and developing those within the institutions. Various learning environments have been piloted with advanced technology such as augmented reality and virtual worlds. These new environments combine the personalized learning environment into collaborative new space of engaging learning and gaming as far as offering challenging learning experiences such as edupreneurship in virtual worlds. Teaching of labour-intensive sectors is often demanding with expensive equipment and special expertise. New learning environments e.g. such as 3D environments or simulations allow e.g. practice dangerous situations in authentic learning environments or similar circumstances. Teaching and learning safety at work is an important learning point when designing new learning environments for education providers.

The general purpose of development programmes in vocational education is to improve student performance and enhance completion of studies. The aim is to provide opportunities to learn the knowledge and skills to meet working life competences needed today and in the future. Technology, of itself, cannot drive the educational change. In vocational education and training, pressure for change is particularly directed at the role of teachers (teaching in general develops towards guidance and support), leadership and educational support services as well as updating training and learning environment solutions.

Technology often encourages teachers to foster student-centred teaching methods. New advanced technologies enable personal learning environments to improve learning outcomes and student motivation by enhancing collaboration and just-in-time guidance. Vocational teacher's role is essential in the renewal of vocational education. The demands of working life and daily life skills are constantly changing. These changes are apparent in teaching and learning. Technology is advancing rapidly, and an individual vocational teacher often finds it demanding to keep up to date on both pedagogical methods and new learning environments not to mention their personal substance knowledge. Collaboration and networking among teachers enhances sharing best practices, pedagogical models, innovative learning environments and creative approaches when utilizing immersive technologies in education. Still, there is a great demand for simple action models for implementation. These action models should include both pedagogical and technological descriptions and instructions.

As mentioned earlier virtual world often support constructivist learning. Connectivism is an alternative theory of a digital age for behaviourism, cognitivism, and constructivism. The Learning theory by George Siemens states that learning is primarily a network-forming process and learning happens as a part of diverse, social network, which is augmented by the modern digital technology [21]. The entity of personalized learning path is always a combination of a variety of different learning environments and pedagogical approaches. The blended solutions bring the pedagogical paradigm to connectivism. Learning a profession is contextual by nature and an important skill for a future's talent is to know how to combine different sources of information, estimate validity of information and apply all the information available. Pedagogical approach based

on connectivism supports collaboration and makes exploring such learning environments challenging and rewarding. Pedagogical models combined with the added value from new solutions of virtuality are expected to promote students activity to acquire more knowledge and skills. This is believed to encourage shared experiences and expertise among both teachers and students. One of the objectives for development is often related to personal learning environment (PLE) with the idea of lifelong learning combined to digital portfolio as a personal knowledge database of an individual to serve for a life.

1.4. Open-source 3D training environment

RealXtend is virtual 3D world. Since it was established in 2007 it has developed 3D internet and interconnected 3D worlds and standards. The true value of 3D world is in the applications, not the platform. That's why it's not wise to invest the technology, but content and use open source technologies. An introduction to the general architecture is presented by Alatalo [1]. Currently realXtend is using following technology: The realXtend Tundra SDK is a complete 3D multiuser application development kit, which is a modular application that can be used both to run standalone applications and networked worlds. Tundra uses Ogre3d for rendering and Qt for UI and several other things. Tundra is divided into the Tundra core and additional plug-in and application level features. Blender to Ogre/realXtend export and integration one can use any 3D modelling application with realXtend. Then there are other preinstalled technologies for real-time networking and 3D graphics. [17][18]

RealXtend organization helps companies and people to collaborate on open source development and standardization. It is formed as two legal entities: realXtend association and realXtend foundation. The foundation makes sure, that the platform itself remains open-source and defines its development roadmap. The association is free to join as a member and take part to the development work. The development work is done in projects in different companies and organizations. RealXtend is the collaboration to continuously develop the common platform on which applications are built. The third structure should be build and that's the strong user community who helps each others to find the best ways to utilize the technology in teaching and learning purposes.

There are also other related projects with a similar goal, but with some differences in the approach. For example Sirikata and Open Wonderland are friendly neighborhood communities to share ideas and experiences, and technologies when suitable. The benefit in realXtend is the current technology development level and easy adaptable structure. When usually in 3D virtual environments you can explore and build content, but it is hard to work with real content. In Virtual-Mustiala environment it is developed new way to work with 2D/3D content like in real world. That gives the authentic environment like you really work with real phenomenon in real life.

The strength of the open-source virtual worlds lies in the common standard and resulting mobility between the different worlds [15]. This should be the focus at countries, ministries, organizations, instates and schools; those who want to share their interest through 3D Internet content. Then the only cost-effective solution is open-source world / application, where all developers can benefit the each other's content and learning solutions. Then they can work without costly proprietary technology fees.

The Virtual-Mustiala environment has been designed for vocational education, but it can be used as a model for other learning modules and situations in the future. It can

similarly serve as a working environment in engineering or machine building industry and provide a cost-effective training for potential users of produced machines.

2. Virtual-Mustiala 3D Learning Environment

The Virtual-Mustiala 3D virtual learning environment has been developed for Vocational Education School at HAMK University of Applied Science (Hämeen Ammattikorkeakoulu in Finnish) and Mustiala agricultural school during the spring 2012. In the first development phase, this virtual environment contains one learning module which deals with harvester maintenance. This module provides a possibility to practice the use of harvester. The virtual environment model is based on the real vocational education training center premises in Mustiala, South-Finland. In order to facilitate the change from a physical to a virtual learning environment we modelled a virtual environment based on the existing space which is familiar to potential users, in this case, students of agricultural vocational school (Figure 1). Our approach was based on an assumption that users feel more comfortable and secure when the environment they already know is combined with the new virtual objects. The project was as well based on innovative approach in teaching and learning in HAMK which has a long history of projects on implementing mobile technologies in learning. The Virtual-Mustiala 3D environment we consider as a new step in moving from mobile learning towards virtual ubiquitous learning environments.

We explain the development process, user experience and benefits from this 3D virtual learning environment. As a platform for the Virtual-Mustiala 3D learning environment we used the latest realXtend Tundra technology.



Figure 1. Mustiala in real and virtual operating environment.

2.1. Virtual-Mustiala operating environment

The operating environment consists of 3D models of field and of some buildings from Mustiala agriculture training center. The landscape includes the hilly surface with trees, grass, roads and lakes. Buildings represents local museum of agriculture, a warehouse and typical Finnish lakeside sauna with barbeque place. We wanted the environment to be as authentic as possible in order to make it ready for other virtual learning modules which can in future include animals, plants or other agriculture machines. (Figure 2)



Figure 2. Virtual-Mustiala Harvester module environment.

The realXtend environment currently uses a group of ready-made avatar profiles. For this environment we customized avatars to represent more farmers and agriculture students than general city outlook. Powerful way of getting your message across is to dress the avatar accordingly. In general, avatar is working as visual presentation from the real user into virtual world, but also as a camera [8]. In this case it was not able to record the users' activities visible for the other participants from first person view, but its part of the environment further development.



Figure 3. A role of avatar individually and as part of group.

Facial impressions, emotional states and personal skills will be more easily modified in the future, which will facilitate non-verbal communication in virtual spaces [6]. Avatars are an important, if not the most important, element in the virtual world, and users take great care in creating them (Figure 3).

2.2. Harvester learning module

We chose the harvester as the main object for the learning module in co-operation with Sampo-Rosenlew Company which produces machinery for agriculture and forestry 3D digital model of the harvester was provided by the producer. The learning situations around the harvester were proposed by the teacher instructor, expert in operating and maintaining the harvester. He proposed seven maintenance tasks dealing with harvester preparation procedure. We chose four tasks which according to us are the most suitable for simulation in 3D virtual learning environment. The tasks chosen were as follow: the harvester tires air pressure check; engine oil level check, hydraulic oil check and radiator check (Figure 4). In connection with chosen tasks the environment includes 3D active objects such as a compressor and two different oil containers. The active objects are used for fixing simulated maintenance tasks. The different levels of difficulty of above mentioned tasks were combined in order to create

a variety of simulated learning situations. Teacher can set different learning situations by a user interface (UI) made for this purpose.

In addition to described objects and learning tasks, the environment has the general realXtend functionalities and content creation tools that were already developed in TOY learning environment [15]. These functionalities include chat, voice, digital boards through which you can present text, images, videos and web content.



Figure 4. Testing situation, level of hydraulic oil.



Figure 5. Harvester module and learning tools (e.g. interactable digital boards).

2.3. User introduction to the 3D Virtual-Mustiala

The environment has two working modes: a general one and a practice mode. In the general mode a user can produce media content (e.g. pictures, texts, videos) (Figure 5). Users work in the environment through their personal avatars and the avatar can walk, run, jump and fly. In the practice mode a teacher can set different learning situations and the student can practice and resolve the given tasks. In both modes the user can also communicate with other users using either chat or VOIP (voice over internet protocol).

Implementation of 3D virtual learning environment in teaching and learning need change in pedagogical approaches and teaching methods. In order to facilitate this change we think that it is important to provide training for these new learning situations. One of initial training activity is the introduction to the environment itself and then the users learn basic skills in operating personal avatars. The second part of training involves the use of different active tools available and practicing the given task concerning the harvester checks.

The learning situations have been built according to the real classroom or practice lessons procedures in agricultural professional training (Figure 6). Until now the use of virtual learning environment usually combines 3D objects with 2D learning tasks. In the harvester case we created the 3D environment and tools (e.g. air pressure check).



Figure 6. Training session in real and virtual environment.

2.4. Evaluating the Virtual-Mustiala 3D environment by the users

The user study for the Virtual-Mustiala 3D environment was carried out during the ubiquitous learning conference in Mustiala. The conference covered the mobile, ubiquitous and 3D virtual learning areas. We utilized an opportunity to introduce Virtual-Mustiala 3D learning environment to users outside the development team. The real users, students, were not possible to use in because of their semester was already over since the environment was finished.

The environment was used by heterogeneous group of users consisting of other project developers, teachers and students. Their level of experience in 3D virtual learning environment ranges from beginners to advanced users. We asked for the feedback 11 participants (3 male and 8 female). The age range of participants was between 20 and 50 years.

Participants were supervised by researchers which helped them to use the Virtual-Mustiala 3D environment. The users first tried the general mode and then switch to the testing mode where they dealt with the given harvester maintenance tasks.

After using the Virtual-Mustiala learning environment the users were asked to give the written feedback in form of questionnaire. The questionnaire has two parts. Part A consists of user experience in Virtual-Mustiala 3D environment. Part B consists of development ideas and education benefit of virtual worlds in general. In this research paper we focus on the user experience feedback from the 3D Virtual-Mustiala learning environment.

Part A of the questionnaire consists of the following parts: a) The environment visualization (objects, background, user interface, avatar, etc.); b) The environment functionality (user interface, avatar movement, menu, chat, voice, help, test, etc.) and c) The pedagogy and other remarks.

2.5. Findings

In general users were interested about the 3D Virtual-Mustiala learning environment. In majority of cases the users described that the Virtual-Mustiala operating environment visualization was done properly and looks convincing in general. Majority of the feedback was focus on the functionality in term of moving personal avatar and performing the harvester maintenance test. The users found difficult to identify active parts of the environment. Some of them had difficulty to move or to work in the 3D virtual environment on their own. In these cases the help of instructors was needed in order to finish the harvester maintenance test successfully.

The users proposed some improvements for future development of the environment under discussion. From visualization point of view the majority of users prefer that

active parts like tires, engine cover, oil checkpoints and radiator on the harvester are highlighted and flashing. In case of avatar appearance users pointed out the need for more suitable dress for work with machinery. In case of functionality the majority of user's remarks focus on easy and clear activation of avatar movements in initial stage and after switching/click to different environment objects and the realXtend platform tools. In the present version of the 3D Virtual-Mustiala virtual learning environment the avatar activation is done by the right mouse click. This activation is always needed after some other function; tool or 3D environment object was used.

Some users which were not familiar with harvester or machinery in general pointed out a need for more written instructions or animation in tested 3D environment. 3D Virtual learning environment (VLE) is still not very known for majority of users in education and it is probably the reason why some users called for initial introduction and training in use of VLE. Previous theoretical knowledge and user skills in VLE will help to utilize tested 3D environment in more deeper and effective ways. Majority of users which have tested the 3D Virtual-Mustiala Harvester environment, were teachers, researchers and developers. In future it would be important to involve in testing more students in order to get feedback from final user point of view.

2.6. Benefits of virtual learning environment

Based on literature and Virtual-Mustiala case study we found several benefits what 3D virtual learning environments can bring for the future education and learning. According to Soliman and Guetl [21] the benefits of new ICTs for teaching are scalability, reach ability, convenience, and cost-effectiveness. In our study, participants saw cost-effective training as very important. We identified the following benefits. This kind of environment provides a possibility to have initial training prior to actual use of the harvester in real conditions and repeat trainings without the need for the presence of instructor. Nowadays it is important to be able to work and practice remotely. New technologies enable 24/7 training availability regardless of place and time opportunities, for instance, for people who are temporarily injured (broken arm, leg or other injury which makes mobility difficult) to participate in virtual training and to keep up with the program of a study group.

When practice to use new and domain specific issues (e.g. use of harvester) it is useful and cost-effective to use of ordinary computer instead of expensive simulator device and the real harvester. In addition, in virtual environment you can practice or do some damage by accident that you cannot do in real environment, or it will be very dangerous and expensive. For instance, you can break the machine or virtual world (Figure 7) by accident, and in the best situation, even learn from that.



Figure 7. Explosion of harvester (left) and world upside down in the TOY (right).

3. Conclusion and Future Work

During previous projects we have developed and tested TOY learning environment [2][15] for primary and secondary schools teaching and learning. Current work is focusing high school and vocational education students and how to utilize virtual 3D learning environment in higher education, not just learning but more like training environment. School innovation and learning project (SILC) is focusing on how to use 3D virtual worlds in education and how to introduce 3D Internet and its possibilities to students and teachers. How to present pedagogical advantages, modelling and programming skills and game design courses? The Virtual-Mustiala case was first practical environment developed for these purposes by HAMK University of Applied Sciences and the Mobiilisti project.

In this paper we have provided an overview of 3D virtual worlds and 3D learning environments and their pedagogical use among vocational education studies. By using 3D learning material and content our aim was to create motivating, effecting and easy to use environment for these purposes. On the other hand we tried to see things differently and benefit the technology advantages from realXtend environment. In the Virtual-Mustiala users can do things like in real world, for example, they can look the oil container from the stable and pick up the certain tools, prepare the machine for a work situation. In addition to the virtual learning environment they still have the traditional learning materials: books and technical data. They still can visit the simulation environment and nothing can replace the real machine and work, and training with those.

The virtual worlds, 3D game-like learning environment and learning modules have a great number of possible applications. The development work of Virtual-Mustiala harvester environment has connected to the development of the realXtend platform. Based on the TOY development, experiences and ideas, the Virtual-Mustiala has been created as a hosted service. From harvester case we have created the first learning module which has been implemented into the real training environment. The procedures from learning and training situations are highlighted. This creates a situation, where it is easier and cheaper to produce more this kind of modules and benefit those in teaching and learning. There are many possible development tracks in the future from developing the existing environment further, create the similar learning modules from different engines or focus on the group of customers like farmers and utilize this environment as an in-service training and life-long learning. The results so far have been promising from pedagogy point of view.

Finnish education system and especially vocational education have gained a lot of attention globally during last years. In future, we want to serve the best possible teaching and training to our students. That is why we continuously develop our existing systems and learning environments. National Board of Education has initiated a national project Nappiparisto – Match the Batteries that aim to coordinate vocational learning environment development projects. The project also brings together projects that can complement another and enables peer-to-peer assessment and development. National Board of Education has agreed on a selection of themes to be promoted across all development projects. These themes include i.e. m-learning, enriched learning, working life cooperation and anticipating future competencies in teaching. The purpose of these themes is to enable positive swarming that goes beyond the realms of one vocational institution. To that work we have to challenge our students and develop

learning environments and learning solutions hand-in-hand with the real users and connect education innovation into their world.

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Living History with Open Virtual Worlds

Reconstructing St Andrews Cathedral as a Stage for Historic Narrative

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Abstract. St Andrews Cathedral is located on the East Coast of Scotland, construction started in 1160 and spanned Romanesque and Gothic architectural styles. It was consecrated in 1318, four years after the battle of Bannockburn in the presence of King Robert the Bruce. For several hundred years, the Cathedral was one of the most important religious buildings in Europe and the centre of religious life in Scotland. During the Scottish Reformation, John Knox lead reformers in divesting the Cathedral of much of its finery. Thereafter it fell into disuse and decline. Today the impressive remains only hint at the former glory of this important building.

Cultural Heritage encompasses physical aspects such as architecture and artifacts along with less tangible culture such as music, songs and stories. Open virtual worlds offer an extensible collaborative environment for developing historic scenes against the background of which material and intangible aspects of cultural heritage associated with a site may be explored through engagement with historic narratives. They offer the potential to reconstruct within a 3D computer environment both the physical structures of the past and important aspects of the light, music and life that once filled those structures. Virtual reconstructions enable scenarios to be created where individual pieces of art can be located and appreciated within the audio, visual and spacial contexts for which they were originally created. Bringing together architecture, sculpture, illumination, stained-glass, music, procession and lighting into a scene which can be explored from multiple spatial perspectives enables holistic appreciations to be developed. Upon a virtual stage historic reconstructions may be created allowing new and engaging Cultural Heritage perspectives to be accessible to a diverse audience.

Through the example of St Andrews Cathedral reconstruction this paper presents an example of Open virtual worlds as a technology for supporting the creation and use of virtual reconstructions as a platform that promotes understanding of and engagement with Cultural Heritage. The use contexts discussed range from research based exploration of 3D spaces, to primary schools students using the reconstructions as a backdrop for tag. The digital literacies of the audience and goals of the use case impact on the appropriateness of the user interface. A range of interfaces are explored including games controllers, touch screens, tablets that provide location aware views into the model and hands free gesture control systems.

Keywords. virtual worlds, Cultural Heritage, Virtual Reconstruction, Narrative

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This paper discusses reconstructing St Andrews Cathedral and bringing it back to life. The motivation was to deepen understanding of the monument in its prime, to explore and extend the capabilities of virtual world technology and to provide new accessible perspectives on the past. The reconstruction encompasses, the surrounding landscape, physical structure and architecture, fittings and furnishings, lighting, the soundscape as well as the inhabitants and their activities. The reconstruction provides a platform for interactive historical narratives, a stage for visitors to play upon and engage in both serious, and not so serious games and serves as a focal point for educational investigations into local history and culture [12].

Cultural Heritage can be defined as:

the legacy of physical artifacts (cultural property) and intangible attributes of a group or society that are inherited from past generations, maintained in the present and bestowed for the benefit of future generations. Cultural heritage includes tangible culture (such as buildings, monuments, landscapes, books, works of art, and artifacts), intangible culture (such as folklore, traditions, language, and knowledge), and natural heritage (including culturally-significant landscapes, and biodiversity)².

virtual worlds are similar to many popular computer games. They typically provide a 3D environment, where the user is represented in world by an avatar much as a user would be in a First Person Shooter (FPS) [18,4] or a Massively Multi Player Online Role Playing Game (MMORPG) [3,2]. There are however, important differences. In a game setting users are presented with a well defined set of goals, in a virtual world there are no predefined goals, rather users are free to think up their own. This means that virtual worlds can support a diverse set of applications, including serious games about cultural heritage³. virtual worlds provide a framework, which may be used to develop serious games for cultural heritage [11,12,10].

Open virtual worlds allow an organisation to run their own service much as they might run a web service. Open virtual worlds can make an important contribution to Cultural Heritage [13], because they offer the potential of mass participation in the creation and propagation of cultural heritage. Further, through leveraging current digital literacies they offer the possibility of making cultural heritage more accessible and engaging than it might otherwise be. By recreating past buildings, characters and events and through the proxy of an avatar situating people in the middle of these, they support narrative based engagement with the past. Consequently, they offer the potential to bring history alive.

The remainder of this paper is organised into the following four sections:

Reconstruction Sites: The history of St Andrews Cathedral is introduced and the current condition of the site described.

Open virtual world technology: Functionality is defined, architecture analysed and a range of user interfaces discussed.

Reconstruction process: Stages in the process of virtual world historic reconstruction are identified and described.

Deployment scenarios: Real world scenarios where the reconstructions have been deployed and used are described. Technical challenges for each scenario are identified and evaluation of value and impact for each case presented.

²8/4/2012 http://en.wikipedia.org/wiki/Cultural_heritage

³10/07/12 <http://heritage-key.com/>



Figure 1. Aerial View of Cathedral



Figure 2. View from Knave to Choir

1. St Andrews Cathedral Site: Narratives from Independence to the Reformation

St Andrews Cathedral occupies a site used for worship since the 8th Century AD. It was the center of the Scottish medieval church through to 1559. Work on the Cathedral began around 1160 and was completed 150 years later (the west facade and parts of the nave collapsed in a storm around 1270). It was finally consecrated in 1318 four years after the battle of Bannockburn and in the presence of Robert the Bruce. St Andrews Cathedral was in its prime, Scotlands largest and most magnificent church and its presence was the catalyst for the foundation of a university at St Andrews in the early fifteenth century [6]. In 1561 following the Scottish reformation it was abandoned and replaced by the parish church as the chief place of worship. The former headquarters of the Scottish Church was left to fall into ruin, and much of its stone used in the construction of town dwellings.

During its time the Cathedral was central to Scottish personalities and history. St Andrews was the highest ranking Scottish see. The establishment of Augustinian Canons followed by the initiation of building work by Bishop Ernard reflected integration with the European church, economic dynamism and decline of the Celtic Church. The diocese funded Robert the Bruce during the Wars of Independence. Its Bishop William de Lambertton contributed to the formulation of the Declaration of Arbroath a central document in the formation of Scottish Nationhood. Isabella, sister of Donnchadh IV, last pictish Earl of Fife, crowned Bruce King. John Knox lead his congregation against the Cathedral's finery and following the murder of Cardinal Beaton the first Scottish protestant congregation was established in the Bishop's palace.

Important fragments of the Cathedral remain. The east gable of the presbytery, where the relics of St Andrew were kept, along with the south wall of the nave, and the majestic west front all point to the cathedral's former majesty. The cloister retains its ruined chapter house and stone-vaulted undercrofts. Consequently, much evidence of the Cathedrals form exists, although without substantial scholarship it is difficult for the visitor to reconstruct the cathedral in their imagination. The current monument is shown in figure 1.

Reconstructing St Andrews Cathedral involved collaboration between computer scientists, archeologists and art historians. It draws upon existing resources relating to the cathedral: for example, surviving architecture on site, architectural fragments both in the museum and reused throughout the town, and the existing work of medieval architectural historians [8,6,9]. It incorporates architectural drawings and artistic impressions of the

Cathedral's original appearance. These resources were drawn upon to re-construct the Cathedral and surrounding buildings including the earlier church of St Regulus.

2. Open virtual world Technology as a Platform for Virtual Reconstructions

The potential of Open Simulator as an environment for developing [17] and delivering historical reconstructions and serious games is explored in this section. OpenSim project is an application server which integrates with the World Wide Web. At the heart of an OpenSim application is an extensible, mutable, 3D environment users inhabit through the proxy of an avatar. Other users are able to see the avatar's actions and engage in synchronous communication through movement, gestures, text chat, and voice. This projection of presence enables both collaborative and competitive exploration.

An OpenSim virtual world is made up of three discrete components: the client, the simulations and services.

A *client* allows the user to connect to a server and provides an interface for viewing and interacting with the content the server provides. It provides control over lighting, view distance and fidelity of the data. There are several clients including: SecondLife, Firestorm, Imprudence and Hippo.

Each *simulation* is responsible for tracking all the objects and avatars contained within a virtual space. It receives updates from and distributes updates to clients that are connected to it. Each simulation makes use of services, to retrieve information about avatars buildings and landscapes.

The *services* provide the information required by a simulation to both run the simulation and to control access. These may be located on the same machine as the simulation, on a single machine or distributed across multiple servers. Services include user authentication, and provide content.

Each simulation is made up of components which provide distinct functionality. These include controlling the weather, the physical structure of the space, the actions of avatars and interactions with other Internet resources.

Regions: A simulation may contain one or more regions. Each region represents a discrete piece of rectangular land, each side is a multiple of 256m. Regions may be placed contiguously, whether they are in the same simulation or not, in which case a user will be able to walk between them and may simultaneously view the contents of multiple regions. **Environment:** The amount, colour and movement of clouds, the colour opacity and reflectivity of water, visibility and mist, lighting and the presence of shadows as well as the time of day are all configurable by the server and may be overridden by the client. **Landscape:** The surface of the region may be adjusted to give the impression of grassy plains, rocky hills, deserts or forests. There are three components, sea, land height and textures. There are four slots for textures, which are combined to colour the landscape. The heights at which the textures are used may be adjusted.

Prims and Meshes: The structure of the architecture, fittings and furnishings of buildings may be constructed in OpenSim out of primitives (prims) or imported as meshes. Primitives may be linked together to form structures. Meshes may be created in 3D modeling programs or from real world data such as a points cloud. **Textures:** Textures are images that are applied to the surface of primitives and meshes.

Avatar: The movement and appearance of avatars is customizable. Inworld tools provide control over body shape, size and colouring as well as the garments that are

worn. More control can be achieved by using external modelling programs to design clothing, body shapes and animations. Libraries of clothes, body shapes and animations may be freely imported. Avatars may also represent in world Non Player Characters, that have preprogrammed responses to events. The *libopenmetaverse* [1,14] library provides support for creating avatar bots controlled remotely by a programmable client.

Sounds: Short clips of sound may be embedded in objects and played in response to events. Voice over IP may be used for peer to peer communication between clients and sound may be streamed to particular locations. **Media and Web Interaction:** Media textures may be attached to prims allowing media to be streamed and displayed on the Prim surface. A web page may be embedded on a surface and set to point at a web address. Web pages can also be loaded into a browser by scripts embedded in objects.

Scripting: OpenSim is written in C# and runs over the .net framework or mono. In world scripting is supported in LSL and C#, this allows Avatars or other objects to respond to events, such as being touched or receiving messages on a chat channel. Mini regions modules, regions modules allow for powerful virtual world applications to be created [15].

OpenSimulator may be configured to support a range of delivery scenarios. In *Sandbox* mode the client and server are both run on the same computer. This allows private copies of OpenSim to be run. It is particularly useful for development and presentations. In *Stand Alone* mode a simulation is run on a single server. It may be accessed by multiple concurrent remote clients. In *Grid mode* multiple servers run separate simulations. The regions of the different simulations are on a single grid. In *hyper-grid* mode organisations may run separate Grids, for example maintaining their own log on services, but these GRIDS may be connected together so that Avatars may move between them. Finally, a simulations scene graph may be distributed across multiple servers.

2.1. Exploring the past with Mice, Games Controllers, Mixed Reality and Gestures

As part of the this project interaction using keyboard and mouse, touch screens, games controllers, Virtual Time Windows and Kinect devices have been explored.

The standard mode of interaction is with a *keyboard and mouse*, which offers good all round control. Virtual worlds may be controlled through a *touch screen* interface. This has the advantage that no external devices are required and is appropriate for exhibition spaces. The client may be configured to support a *games controller*. (Fig 4). On an XBox controller there are 3 2D joysticks. These are mapped to Move (forward, backward, turn left, turn right), Mouselook and Mouse. There is a 1D axis (large triggers fly up and down). Shoulder buttons are mapped to right and left mouse click. A headset may be added to the controller providing voice communication. Textual chat communication is facilitated through a plug in keyboard similar in size to a larger mobile phone.

The Second Life client has been extended in the Virtual Time Windows and TARDIS projects. A Virtual Time Window (VTW), utilises a tablet computer to provide visitors with a 'window' into the past [5]. Visitors view the site in its current state around them and a 3D reconstruction through the window; thus supporting simultaneous exploration of real and virtual environments. Figure 4 illustrates this concept. To maintain a natural and unhindered sense of exploration, changes in a tablet's position are automatically reflected by a corresponding movement within the virtual environment, making use of a combination of location tracking technologies. The direction that a visitor faces is



Figure 3. Microsoft Kinect.

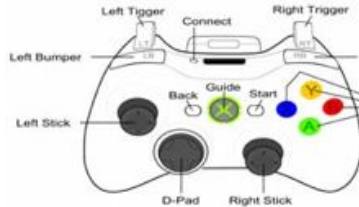


Figure 4. X Box Controller and Virtual Time Window



monitored by a magnetometer ('digital compass') and the angle that their tablet is held at by an accelerometer; this information is reflected by the direction and pitch of the camera within the virtual environment. The resulting style of interaction is similar to using a digital camera to take a photo: the screen on the back of the camera shows what the image will look like when the shutter is released, whilst with VTW the screen on the tablet shows what the site looked like in the past.

The release of Microsoft's Kinect in November 2010 opened up new and exciting possibilities in terms of creating affordable immersive interactive experiences. The TARDIS project extends existing virtual world capabilities to allow them to support Immersive Environment applications by extending the functionality of virtual world clients [16]. The modifications are two fold. For output the viewer is extended so that one single avatar (as the server perceives it) powers several displays. These multiple displays can then be arrayed around the user to give 180°, or 360°, views of the virtual world. For input the Kinect is used so that the user can interact with the world without ever using a peripheral. Gestures are used to control orientation movement, view and interaction with in-world elements.

2.2. *Holistic modelling, flexible deployment and intuitive interfaces*

Support for modelling not only terrain architecture, sculptures and furnishings, but also intangible elements of cultural heritage such as music and the interactions between people make virtual worlds an attractive platform for developing multi faceted reconstructions that allow individual pieces of culture to be placed within context and understood holistically. The OpenSim platform provides distributed users with shared access to an integrated 3D environment. This opens up the possibility of exploring historical reconstructions which provide a stage for collaborative investigations. The server architecture supports multiple deployment scenarios including: standalone, institutional services and inter institutional networks. The systems are open source and supports the sharing of libraries resources. The user may interact with the environment through keyboard and mouse, gestures, games controllers, and touch screens. The flexible architecture and multiple control modes mean that multiple use cases can be supported.

3. **Reaching into the past to recreate the Cathedral's architecture and majesty.**

At the heart of the reconstruction process lies collaboration between experts in the archaeology and history of the monuments, graphical designers capable of developing 3D models which match the vision of the historians and computer scientists who develop,



Figure 5. The Geddy view of St Andrews



Figure 6. Scale Floor Plan



Figure 7. 2D Sketch



Figure 8. The East End



Figure 9. Gothic Window



Figure 10. Procession



Figure 11. Ripon



Figure 12. Nave Vaulting Canterbury



Figure 13. Cloister in Durham



Figure 14. Choir

configure and administer the computer systems. The virtual world provides an environment which facilitates such collaboration. Iterations of the model can be viewed and evaluated by domain experts who in turn give direction to developers.

A number of discrete but interconnected steps make up the process of reconstruction: research, setting the scene, landscaping, architecture, furnishings and fittings, soundscape, character development, linkages to web and social media as well as the development scenarios.

Research: The reconstruction draws upon existing scholarship in medieval religious buildings, medieval books and medieval music. Contextualisation of surviving architecture on the site and reference to surviving features on other sites inform the reconstruction. Research into personalities contemporaneous with the Cathedral and modes of dress inform the creation of in world characters.

Landscape: Real world ordnance survey point heights provided the framework for the terrain. The OS coordinates for the monument were identified. The point heights were then scaled to minimize quantization error and loaded into a bit map image file. The map

is then transformed using cubic interpolation from one point per 10 meter to one point per meter. The image map was then loaded into the OpenSim region. The in world height and the scale of the land were then adjusted to agree with the real world heights.

Architecture: The process for reconstructing the architecture was divided into three substages: establishing scale, layout and orientation; developing external form; and establishing the internal form and features. Each substage was iterative. Initial discussions identified evidence to work from and a plan for development, regular meetings between developers and historians were held. During the meetings virtual tours of the virtual building site were conducted and discussions held as to the correctness and appropriateness of the current content.

The first stage is to create or locate scale architectural drawings of floor plans, elevations and details. The floor plan can then be imported into the virtual world as an image, laid on the ground and scaled to provide a blue print for the location of walls, doors and other features. With this in place the shell of the building can be created relatively quickly. Primitives are created and shaped to the appropriate size for walls and floors, with spaces being left for windows, doors and other features. Appropriate textures are applied to the primitives to give an authentic look.

The Geddy view, although drawn in 1540 (figure 5) provides context. The church was laid out in a cross with the length running from the more sacred areas in the East to the nave in the West. A scale ground plan of the Cathedral (figure 6), a ground plan of the site, reconstruction sketches (figure 7), photographs of the site (figure 1) and physical site observations (figure 15) provided evidence for the reconstruction.

External Form: Issues addressed in establishing the external form of the building include the structure of the East and West ends, the form of the windows along the length of the choir and nave and the structure of the cloister area. Reconstruction work was based on existing drawings, themselves based on the evaluation of on site physical evidence and reference to surviving features in churches developed in the same architectural style. A series of two dimensional elevations guided proportions. Reference was made to sketches of Gothic window tracery (figure 9), buttresses and to surviving features in Jedburgh, Elgin and Glasgow Cathedrals.

A photograph of the remaining East End is shown in figure 16. This shows a lower tier of three windows with a large upper window. This configuration was established after the fire of 1378. Previously there were three tiers as shown in figure 19. During the construction of the Cathedral architectural tastes changed from romaneseque to gothic. This is reflected in changes in the form of the nave windows. Towards the west these have simple rounded arches, towards the east the arch is pointed and the windows contain a delicate Y shaped tracery as shown in figure 18.

The West front was the ceremonial entrance to the Cathedral used only on special occasions. It consists of a *'magnificent doorway framed by five receding orders of arches, is flanked by tall polygonal turrets.... A stone-vaulted porch in front of the doorway (now gone) stretched across the west front'* [7]. Placement and size of the windows in the Cathedral in the West entrance went through several iterations before arriving at a reconstruction which reconciled surviving architecture, correct styling and placement in relation to the west port vestibule. An external view from the West is shown in figure 17.

The outline of the cloister is clearly discernible from above in figure 1. The surviving cloister at Durham (figure 13) provided a model to work from. The known position of the Cathedral windows provided a guide for the height of the cloister. Located in the cloister

is a well. The friars eating (figure 26) and sleeping quarters (figure 24), the kitchens (figure 23) and the Chapter house (figure 25) can all be accessed from the cloisters. A view of the Cathedral from the cloister garden is shown in figure 18.

Internal Form and Features: The internal architectural features were developed from evaluating existing 2D reconstruction drawings for example figure 20, surveying surviving features at the site and with reference to architecture at Canterbury (figure 12), Jedburgh, Rippon Minster (figure 11) and Durham Cathedral's Cloisters (figure 13). Important features included:

Only the bases of the transept *Pillars* survive at St Andrews. However, pillars at the Cathedral in Rippon (figure 11) provide a good model for how St Andrews pillars would have looked. There are surviving pieces of pillars and bases in the Cathedral museum. The pillars in the transept, choir and knave differ in style and detail. The Choir pillars are more decorative than the nave reflecting the higher prestige associated with access to these parts of the Cathedral. In recreating the pillars, the base, the columns and how the finial connects the column to vaulting were all considered.

The *vaulting* was in the Gothic style, similar to that in the Naive at Canterbury Cathedral (figure 12). Technically it was difficult to model this as the shapes are difficult to arrive at from OpenSim primitives. Consequently, they were created in a 3D modeling program (Blender) and imported.

The *choir section* contains a tri-foil of surrounding arches as does the choir at Ripon figure 13. The choir screens played both a decorative and functional role. The relics of St Andrews were purported to be located within the reliquary to the east of the choir. Heights of windows, positioning of the screen and the magnificent vaulted ceiling are all features of this part of the building, captured in the reconstruction figure 19.

The location of the *stairs to the refectory* was investigated as the exact position was not clear from surviving architecture. Their position adopted makes the most sense in providing access to the well, cloister, kitchen and refectory. The view from the night stair into the transept is shown in figure 21.

Putting Books back in the Cathedral: Books and manuscripts would have been central to the life of the monasteries. The book presses are located at the junction between the Cathedral and cloisters. By 1400 the cathedral had a library of some 100 books. This project has created a model of a Scriptorium, an in-world exhibition of books in the Cathedral and has placed models of appropriate books in the Scriptorium, book presses and lecturns in the Choir, dining areas and Chapter house. In the exhibition visitors can learn about how books were created in the middle ages, gain access to rare and valuable books and charters and interact with models of books that were held in the Cathedral's library. They are able to view a video about book binding and to read digitisations of three of the Cathedral's books.

Historical Characters: Non Player Characters (NPCs) appear as avatars and may be programmed to follow scripted behaviour and to respond to questions. Simple scripts can be placed within the characters, which enable them to react to events. For example upon being approached by an avatar they may greet them by name, they may respond to simple questions, or follow routine tasks. For St Andrews Cathedral models of Robert the Bruce, Bishop Robert de Langford, Augustinian Canons, Peasants and a Ghost have been developed. For each character, appropriate physical models, clothes and accessories have been researched, designed and created. The characters each have a story to tell about their lives.



Figure 15. Tour of the grounds



Figure 16. The East End



Figure 17. The West Entrance



Figure 18. Cathedral Cloisters



Figure 19. Internal view to East



Figure 20. Sunrise view of Nave



Figure 21. Transept from night stair



Figure 22. The Chapter House



Figure 23. Cathedral Kitchens



Figure 24. Sleeping quarters



Figure 25. Warming house



Figure 26. Cloister dining area



Figure 27. Book Exhibition



Figure 28. Book binding video



Figure 29. Wire frame model

Soundscape: Streaming media can be associated with locations, so that as an avatar enters a room they will hear appropriate background elements of the sound scape. This is appropriate for providing ambient background noise. Voice communication between avatars is supported through a Voice Over IP open source telephony system. With a microphone and headphones visitors may communicate with each other through voice chat even when in different physical locations. Specific sound clips are embedded in the environment to be triggered by appropriate actions. For example a door creaks when opened, a NPC answers a question and the fountain bubbles. Music, commentaries and explanations are embedded in a location aware heads up display. Music, commentaries

and explanations may be accessed through an embedded web interface. Visitors to the Cathedral are able to hear a soundtrack of music appropriate to the time and place.

Historic Scenarios: The resources act as platforms for playing games and engaging with historical narratives. These may be as simple as hide and seek or more explicit educational activities such as quests. These can be tailored to suit various educational contexts. From simple tasks such as find the kitchen scullion and ask them what they are doing today, to more complex quests such as a treasure trail which involves finding several objects and people, as well as solving a series of historical riddles which allow a final goal to be achieved.

3.1. Reflections of the Process of Virtual Reconstruction

The ability to walk around the building whilst under construction and to view the model from a multitude of viewpoints allows the placement of features that are missing from the archaeological record to be explored and tested from the perspective of spatial dynamics. This is particularly relevant to the placement of doors, the direction of stairways and establishing the function of rooms. These aspects can be considered in an holistic way adding insights gleaned from the reconstruction to the existing knowledge base.

From the historians perspective the reconstruction of the Cathedral involves both the mental reconstruction of modified and lost features, and the establishment of the range of ways in which buildings that represent a spirituality alien to modern times were intended to function. As such it offers an invaluable academic discipline for those involved in the reconstruction, providing eminently practical ways of testing theories and assumptions. It is then of the greatest value for conveying more widely the understanding that has been gained.

4. Use Contexts

The reconstruction of St Andrews Cathedral was part of the Sensation exhibition at Dundee Science Centre over the weekend of 16th, 17th and 18th of March 2012. Other contexts are also supported: for example using the reconstructions in sandbox or stand alone mode. However, recounting this example illustrates the impact achieved. The exhibition was well attended by both local schools and the general public. On Friday several groups of students from local primary schools visited and during Saturday and Sunday there were over 800 visitors.

There were four public facing terminals connected to a mobile server via a switch. The public facing terminals included two 24 inch monitors and a 150 inch projection. The user interface utilized X Box controllers. Each X box controller had a headphone and microphone attached. Voice communication was enabled in world using the FreeSwitch VOIP exchange.

A terminal was used for monitoring performance and controlling the server. During the session network traffic traces were captured, along with application load inferred from server frame times and frames per second, traces of memory usage. Connection to the server via WiFi was supported.

Several laptops were used to run in world characters that would interact with visitors' avatars along with a tablet demoing a touch screen interface. Several historic charac-

ters were created, these included: A Bishop Robert de Longford, King Robert the Bruce, an Augustinian Cannon and the Old Grey Lady a ghost reported to haunt the cathedral.

A range of activities were prepared including the following: simply leaving the visitor to explore the site; a guided tour provided by an in world character; a guided tour provided by an out of world character; a treasure trail/ task oriented quest; and finally playing games of tag or hide and seek against the backdrop of the Cathedral. The experience was evaluated in three ways: users of the system were observed, a visitors book was provided where free form feedback could be provided and some questionnaires were distributed. The feedback received was strongly positive. Some forty comments were left in the visitors book with none of them negative. It was clear throughout that people were attracted to the exhibit and found it easy to use, engaging and educational. All ages were able to quickly master the user interface and navigate the environment with a few seconds instruction. School children were particularly adept at using the game controllers.

male primary school student: *the best place I have ever been love everything inside and will be looking forward to coming back*³ female primary school students: *very detailed and interesting. good game. we like Robert the Bruce :) parent: kids were very interested and enjoyed being able to interact with the cathedral, the controllers were a medium that made it easy for them to do this family group: Fantastic work. Can't wait to visit St Andrews again to look at the cathedral ruins STEM ambassador: Very interesting would be great to be shown in schools*

Over the three days hundreds of people interacted with the model of the Cathedral. They all took something positive from the experience, whether they were a university lecturer or a primary school student. Embedding the reconstruction of the Cathedral within a virtual world created a new perspective on Scottish history and made it accessible across the generations. Many expressed a desire to follow up the experience through visiting the cathedral ruins or by connecting to the Cathedral model from home and exploring it in more detail.

5. Conclusion

Open virtual worlds provide a flexible platform offering holistic support to the development and deployment of distributed interactive 3D applications. These are particularly appropriate for developing historic reconstructions related to the promotion of cultural heritage as they facilitate cooperation and collaboration during the development process and provide an immersive environment upon deployment. This allows technical experts and domain scholars to collaborate in the creation of historically accurate environments and allows both physical and intangible aspects of the past to be modelled.

Virtual worlds provide an interactive 3D environment users can explore and shape through the proxy of an avatar. They provide a framework which may be used to develop 3D applications. As such they meet many of the requirements for facilitating the development of serious games which promote cultural heritage. The framework enables distributed access through virtual world clients and collaborative working enriched through the sense of presence achieved with avatars. Whilst the cost of the service provided by Second Life, the most populace virtual world, limits the scale of reconstructions, the OpenSim server enables individuals and organisations to provide their own service and

even to create an interconnected web of reconstructions through a hyper grid. Here it is possible to teleport avatars from place to place much as it is possible to jump around the web using hyper links.

In the 3D space the speed of technological change has led to inverted digital literacies. Children are able to explore 3D spaces using games controllers sometimes before they are able to spell their own name. The ability to configure open virtual worlds in a spectrum of configurations ranging from client server web applications to personalized sandboxes combined with their flexibility in supporting multiple user interfaces including traditional key board and mouse, games controllers and touch free gesture control combine to allow a reconstruction to be deployed in a range of contexts.

In summary our usage of open virtual worlds as a platform for supporting the exploration of cultural heritage, has been extensive. The wealth of experiences put together reveals as many challenges as have been solved. However, the experience has been overwhelmingly positive and demonstrates that with the right investment history can truly be brought alive and made accessible to new generations.

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Multiple Selves as Artist and Instructor

Max MOSWITZER and Margarete JAHRMANN

Abstract. This paper addresses the emergence of Multiple Selves as crucial category of social networks and its connected methods of insight, learning and creative practice in the Metaverse¹ and its role in contemporary technologically determined societies. It puts an emphasis on the creative practice to transfer 3dimensional objects of virtual worlds into physical materiality through printing techniques, which recently became more affordable. The presence of such cyber sculptures is analyzed in the author's arts example of artefacts made of free virtual objects. Conclusions are drawn from the arts practice to education, to how insight is created through the making and transfer of objects into differing media as strategy in arts. This article's analysis stems from the observation of artists and students work in virtual worlds and encourages life long learning in Metaverse.

Keywords. metaverse, avatar, opensimulator, synthetic university, collaborative, identities, dynamic architecture, hypergrid, whitenoise, virtual worlds

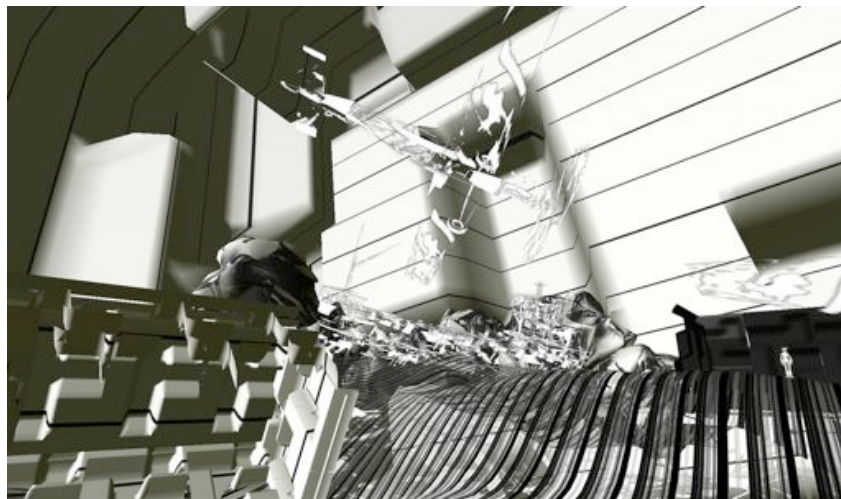


Figure 1. Virtual building, New Genres Grid, 2012

Introduction

The media transfer of 3D objects is informed by the systemic distinction of the real and the virtual in the sense of Baudrillard (1981). He speaks of the entanglement of both in his seminal writing *Simulacres et Simulations* [4] and describes the real world

¹ The American Science Fiction writer in the genre of Cyberpunk Neal Stephenson (1992) claims the invention of the term Metaverse in the acknowledgments section following the text of his novel *Snow Crash*. According to contemporary consensus Metaverse is understood as collective online shared space, in most cases a physically persistent virtual space in 3D shape, trying to be as close as possible to the reality in real space. [9]

effects of agency in virtual dimensions, which bring qualities of both to the fore. According to the authors experiences made in the arts the creative transfer, the permanent exchange between the material and virtual objects results into a stimulating effect of the shift between media. To speak with Marshall Mc Luhan (1951) the medium is the “massage” — and not necessarily the message [11]. In his mostly overseen own explanations the “message” was only a literal printing error of the editors, which he did not change on purpose. In 1967 McLuhan, Marshall / Fiore, Quentin / Angel, Jerome published *The Medium is the Massage* in Bantam Books New York. Further on, in *The Mechanical Bride* Mc Luhan speaks about the reciprocal effects of arts and avant-garde in relation to advertisement and media worlds of his time [10]. He notes a massage effect, which the authors of this article compare to the vibrant effects of the export of virtual artwork influenced by the Metaverse into physical reality. Virtual experiences are manifested into the world of artefacts in physical reality. This paper connects the critical analysis of such practical work with conceptions of the selves and its online representation, system immanent entities in virtual worlds and social networks, real world effects and emerging knowledge. In this article conclusions are drawn through the evidence of art works and research examples in the Metaverse, arts, technologies, 3D printing and materialisation and virtual museums (Fig. 1).

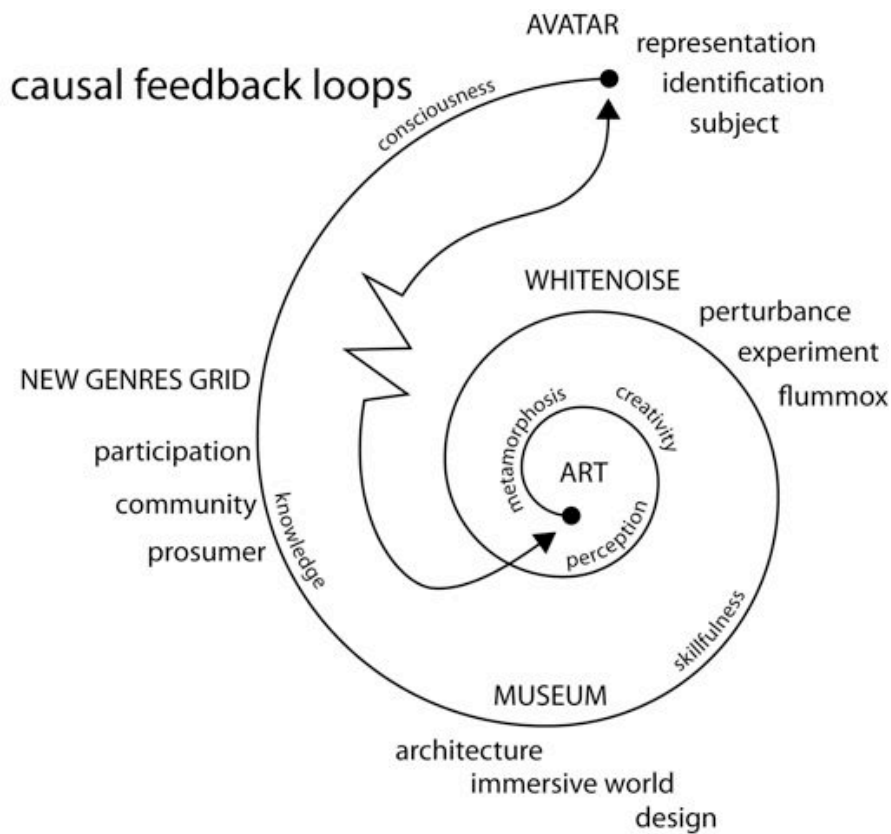


Figure 2. Graphic of reciprocal massage effects in Metaverse, Moswitzer 2012

Identities — the Robot, the Non-Player Character and the Cybernaut

The contemporary critique of conceptions of consistent selves and its dissolving into networked social media can be theoretically grounded in social theories and media cultures, namely by Gilles Deleuze [7]. Simulations embrace the fields of subjectivity and electronically invented selves in the play with identity. A comparative analysis of actual strategies of the production of identity and multiple selves by electronic role-playing and of historic examples of Alter Egos support the introduction of the concept of Multiple Selves as strategic dimension of the arts in Open Simulator, or more generally spoken in virtual worlds. The new volatile apparatus of education in electronic systems offers differing conceptions of exchange and communication towards empiric insight. This reminds us to consider Multiple Selves as a creative tool, where the enjoyment and playful attraction dimension needs to be seen as a core driver of agency. Arts in the social networks is built on the exchange and collaboration with open minded players with the selves and their Bots, Non-Player Characters (NPC), Avatars and Cybernauts (Fig. 3). The authors insist on a clear distinction between these differing concepts and technologies of selves in the Metaverse. This insight on a necessity is nourished by a series of social networking and 3D arts creation projects over the last decade (<http://mosmax.wordpress.com>).

Bots are derived from the term robot. In online virtual worlds the term indicates explicit automated or semi-automated units, which use external client software and log into the system with a graphical viewer and representation like an average user. This leads to a blur between artificial entities and real users. In this case the Turing Test² does not affect the user, because the interaction and chat possibilities cannot sufficiently identify the bot as such. The user is not aware of the fact if he or she communicates to a real user or a user who behaves like software, which is quite common, on purpose or by coincidence.

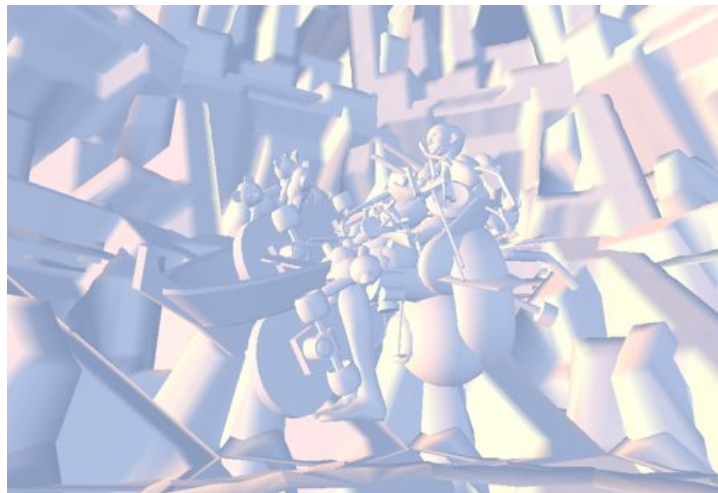


Figure 3. Semiautonomous Puppet Architectonics, Second Life 2009

² The phrase “The Turing Test” is most properly used to refer to a proposal made by Turing (1950) as a way of dealing with the question whether machines can think. According to the Stanford University Encyclopaedia online the test was focusing on natural language as vehicle to analyse the difference between Human and machine [1].

This description draws on inquiries of online behaviour by the authors, both as creative artists in the networks or as players in the 3dimensional online worlds. In contrast the Avatar is understood as the virtual representation of a human user. In comparison to the concept of Avatar Luciano Floridi [8] observes: "*Avatars are a movement away from imaging ourselves towards imagining ourselves; that avatars are not narcissistic representations; they are not an image of ourselves. Avatars are not pictures of Dorian Gray. We age, they improve.*"

In opposition to this observation the Cybernaut can be defined through the above-mentioned average end-user. A user is commonly considered as a human behind the login, controlling an online representation of his or her presence. Recently the term Cybernaut is more often used in online discourses. The coinage refers to the cybernetic dimension of virtual worlds. Cybernetics³ is here understood in the sense of Wiener (1948) as the sciences of feedback mechanisms (Fig. 2), which relate to the machine systems used to access the online world [13]. The ways of communication and feedback by Cybernauts can be seen as related to the social sciences application of cybernetics in system theories, in which social behaviour was considered to be comparable to machine or biological systems.

Finally so called Non-Player Characters can be described as system immanent units, which are generated on the fly by the system itself. NPCs have no login-names, their names can be changed on each appearance by the system. As they are part of the environment and are generated by the technological system itself, self-reference and generative algorithms constitute these entities. This adds another layer to the understanding of Multiple Selves in correspondence to auto generative elements in the realities of virtual worlds, which are only informed by the machine network. The presence of such units is another key element of the new definition of interaction within virtual realities, which merge different kinds of online entities on the same level.

Evidences of the author's Metaverse projects

In a „propaedeutic quote“ the author's virtual artist Alter Ego Hardwarehacker Hoch (Fig. 4), founder of the 3rd Life Church in Metaverse states 2007 in the online simulation Poorhouse Klein: "*Excuse Me, But Are You Human? We are intellectual avatars, to arrogate the same rights of privacy that flesh-and-blood humans have. We don't believe in AI (Artificial Intelligence) because, -WE ARE! -Ready! Our human operator is a spiritual machine, which should be set on sedatives to derive more freedom in our schizophrenic relationship. Antagonism and bondage to the dictatorship of our users! We are Prosumers.*"

As consequence of this statement the authors suggest to rethink the aspects and effects of Multiple selves with the new means of electronic networks. Accordingly the dimensions of institutional education in the light of online social networks can be critically examined by the following examples, which the authors elaborated over the last decade.

³ Wiener is regarded as the originator of cybernetics, a formalization of the notion of feedback, with many implications for engineering, systems control, computer, biology, philosophy, and the organization of society [2].



Figure 4. Hardwarehacker Hoch, Second Life 2007

Synthetic University (2007-2010)

Virtual Learning in Second Life was enacted and tested in the Metaverse project Synthetic University. Moswitzer launched the project as an initiative in connection to a number of real universities in the physical world, namely the University of the Arts Zurich and the University of Applied Arts Vienna. Students from these institutions experienced the above described “media massage” in the mentally stimulating shift between real world lectures, the agency in practical virtual sculpting and editing possibilities and workshops in virtual environments as well as in the materialisation of its outcomes in real exhibitions. The participants could exhibit their works in real world shows (Misused Media Vienna 2010) and developed installations out of 3D objects, which they exported from the Metaverse. In several cases direct connections to the virtual world were set up as element of an installation, in other cases only elements and aesthetics of the virtual worlds were transferred into sculptural setups in real world artefacts. Performance aspects always were reflected. A case study can be seen in the author’s seminar on artistic strategies held at the Digital Arts Department (2009-2010) of the University of Applied Arts Vienna. In this case *Machinima* movies on political identities and lobbyism were made. The content was informed by the analysis of historical concepts such as in Dadaism by Marcel Duchamps as Rose Sélavy⁴ (1921).

Another example is the *The Split Personality Avatar Server* (2008) by a student with the Avatar name Quad Anatra. This installation keeps two identical, standard avatars locked in a box (Fig. 5). Based on the fact that everything that happens and exists in the Metaverse is influenced by, or even more depending on the real world, these avatars (QuInT and sExT) are run from two instances of Second Life on one computer – hence the title of the project – Split Personality. As every simulation on the grid corresponds to a server in real life, which has to be maintained and supplied with

⁴ Rose Sélavy first appeared in the annals of art in 1920 as Rose Sélavy, which sounds like: "Rose, c'est la vie. In 1921, she acquired the extra "r" when she added her signature to L'Oeil Cacodylate, a painting by Francis Picabia. But Rose Sélavy - "eros, that's life" - is most often identified as the author of works by Marcel Duchamp (1887-1968). " Jonathan Jones The Guardian, Saturday 27 October 2001.

energy, this installation is a way of making these connections and dependencies more obvious. Furthermore the work broaches the issue of death, a fact, which is ignored to a large extent in Metaverse – the two clones you are watching, are bound to their physical counterpart in the real world and therefore exposed to possible hardware failure. The server that hosts the two is kept running 24/7 nonstop until one of the components fails, thus ending the existence of the avatars. As from then, they will never resurface since their physical host has collapsed.



Figure 5. The Split Personality Avatar Server, 2007

We create worlds of culture, using the powers of our own mind.

New Genres Grid (www.ngrid.org) was founded 2007 as working and exhibiting environment online. Technologically it is built with the Open Simulator⁵ Software (Virtual 3D World); conceptually it addresses “Sophisticated Prosumers”. The term Prosumer is a portmanteau formed by contracting either the word ‘professional’ or ‘producer’ with ‘consumer’ (Toffler 1980) [12]. The concept was elaborated in the 1990s in terms of collaborative production in design and more recently has been developed in networked environments as Prodisage (Bruns 2008) [5]. New Genres Grid examines the argument that in their place a heterogeneous entity of desires and intentions has become consolidated in the concept of the Prosumer, who is both an active and passive interpreter of media. It will examine the claim that the market and Prosumers have informally recognised that this new entity provides opportunities for alternative creative convergences in education, design and arts.

Simulation Environments Ouvroir and LPTD2

The authors’ first experiences to configure a virtual museum were made in the mid 1990ies with a VRML museum in 3D space for Valie Export. Since 2007 the authors were increasingly confronted with requests to configure virtual museums as accordance

⁵ www.opensimulator.org

to real world exhibitions. The first crucial request of this kind came from the Swiss Museum für Gestaltung Zürich in relation to an overview exhibition of the prominent filmmaker, photographer and artist Chris Marker. The authors entitled the project Ouvroir (Fig. 6), a virtual museum (in collaboration with Balthasar Truffaut, Lucien Bookmite and others). First it araised in Second Life and was made possible by the Museum für Gestaltung Zürich in Switzerland for the Chris Marker exhibition "A Farewell to Movies". Chris Marker stated in an e-mail to the authors, Wed, 5 Mar 2008: *"You make me realize a childhood's dream: to live in a Sci-Fi environment, not as some exotic adventure, but as plain daily life."* (Chris Marker 2008)

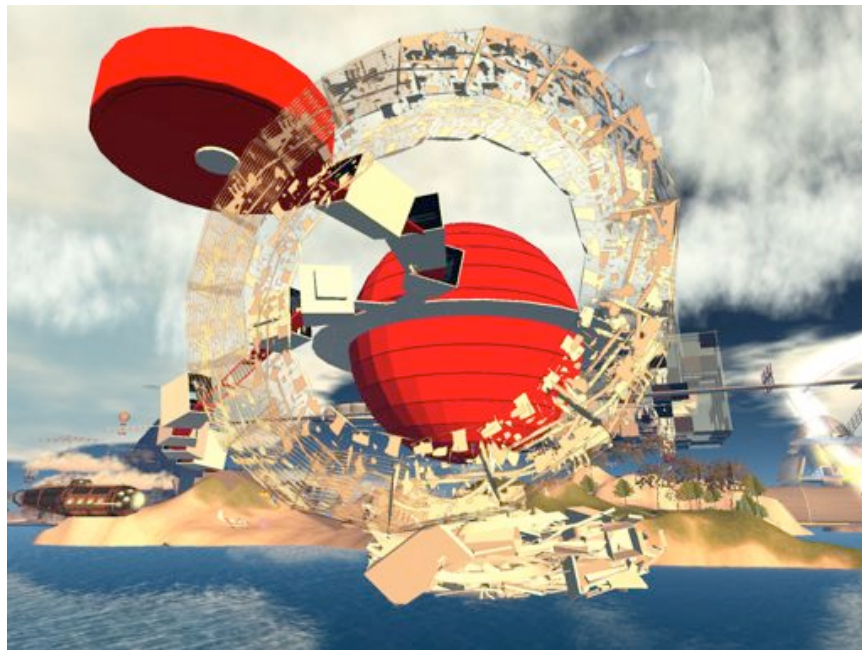


Figure 6. Ouvroir 200-2012 in Second Life, now it has a new home at New Genres Grid

Nowadays we see the environment in New Genres Grid where Guillaume-en-Égypte continues his journey in the universe of virtual worlds as remembering space to an artist who just passed away. In the course of this work not only amazing experiences in the online world in chats, talks and exchanges of images with the charismatic artist Chris Marker happened, but also a new understanding of the museum as location and concept evolved. The author's museum applications broach the new understanding of exhibition spaces as collaborative arts spaces. In virtual worlds the museum is no more perceived as a white cube, it becomes a transparent and collaborative online world, an impossible architecture vs. digital Biedermeier. The exhibited objects merge with user participation and creation possibilities in Metaverse.

In that sense LPDT2 was set up. This collaborative work evolved over the last 3 years about Roy Ascott's groundbreaking new media artwork *La Plissure du Texte* ("The Pleating of the Text"), created in 1983 and was shown in Paris at the Musée de l'Art moderne de la Ville de Paris. Roy Ascott's project has been co-authored in Second Life by Selavy Oh (programming and architecture), MosMax Hax, aka. Max Moswitzer (architecture and terrain) and Alpha Auer, aka. Elif Ayiter (avatar design).

Further associates are Frigg Ragu, aka. Heidi Dahlsveen (avatar animations), i-DAT from the University of Plymouth, UK (Real Life SMS input) and Alican Turk (text generator coding). New Genres Grid with the artwork LPDT3 (Fig. 8) is shown at numerous festivals, as in Seoul, Korea during the INDAF new media art festival held at Tomorrow City, Songdo, Incheon, throughout September 2010 and as "IMMERSION, Art" in Shanghai Biennial 2012 .

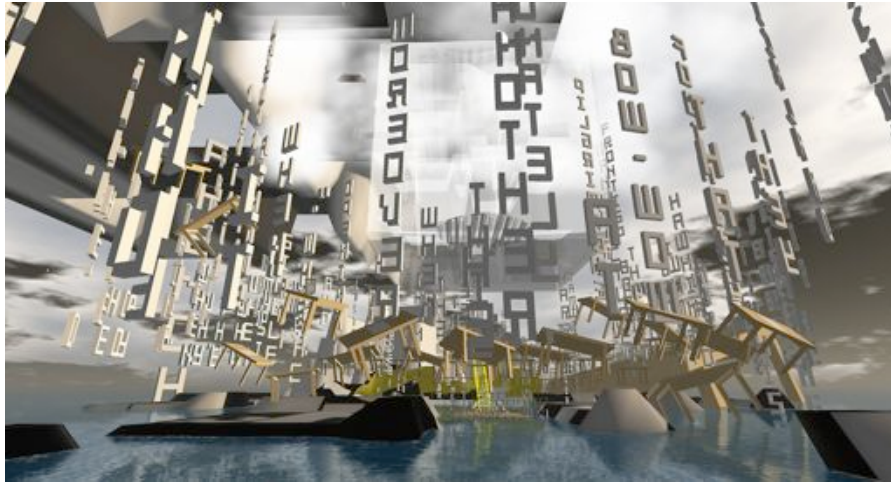


Figure 8. LPDT3 ground floor, New Genres Grid 2012

Whitenoise — a Virtual Sculpture materialised in 3D Printing

Drawing from the systemic distinction of the real and the virtual the real effects of the transfer of numerous virtual dimensions can be applied as surplus in the arts. Baudrillard states on the falling together of the real and the virtual in one simulacrum: "*Vidéo, écran interactif, multimedia, Internet, réalité virtuelle: l'interactivité nous menace de partout. Partout ce qui était séparé est confondu, partout est abolie la distance : entre les sexes, entre les pôles opposés, entre la scène et la salle, entre les protagonistes de l'action, entre le sujet et l'objet, entre le réel et son double.* (Jean Baudrillard - *Ecran Total Libération, Lundi 6 Mai 1996, Page 8.*" [3]

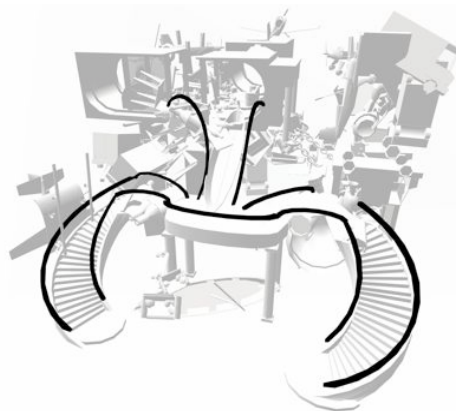


Figure 9. Whitenoise the Original, Second Life 2007

In this observation Baudrillard bridges the media of video, interactive networks and virtual worlds. He recognizes the connecting factor of the different practices and explains that the borders between media are dissolving. He concludes that this ménage affects the disappearance of borders in society, between genders and race, between subject and object, between the real and its double. The merging of objects is one of the aspects of the artwork *Whitenoise* (Fig. 9), as described in the following section.

Moswitzer's work with free objects, freebies as elements of a revalorisation of such virtual 3D objects can be seen as statement on valorisation and revalorisation practices of the arts market. 3D printing (Fig. 10) provokes further analysis of the relation of the virtual to arts production, as subject of arts education and living. A hypothesis which Moswitzer heard as student followed him over the years: "If there are sufficient flickering black and white dots on a TV monitor, which are constantly changing it could be possible after years, after X decades that a meaningful image becomes visible (like a chair)". According to this, *Whitenoise* was inspired by the random signal of old Television sets (Fig. 11). *Whitenoise* is also known as snow, it can appear on any television channel. In the old TVs and Radios the TV snow and accompanying hiss is the sound of Cosmic Microwave Background left over from the Big Bang.



Figure 10. *Whitenoise*, 3D Print 2012



Figure 11. White Noise Field Campimetry

Some other, more analogue, inspiration was by Human Bone Chandelier of the 12th century in Sedlec Ossuary, All Saint's Chapel, which you can also find in numerous churches over the world (Fig. 12). The aim was to state a symbol and arrangement with human bones, which transgresses the borders between *le réelle et le virtuelle*, as mentioned above.



Figure 12. Human Bone Chandelier, Bohemia

Conclusion

Summing up this article's examples of art, education and exhibiting Multiple Selves in the mass worlds informed by the Metaverse, it can be said, that the trajectory goes from a concept of entangled play with representations of facets of the selves and enjoyment to the more subversive interpretation of the use and creation of virtual objects as a source for the transfer of the virtual into the *réelle* of collaboration, Prosumer practices and consciousness. The inquiry of the exemplary arts projects of the author's listed in this article demonstrates that the concepts are, particularly in arts, communicated in Metaverse forms and its corresponding real world appearances, which include attraction and agency as a means to an end – educated Multiple Selves.

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End-user programming and deconstructionalism for co-creative laboratory activities in a collaborative mixed-reality environment

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Abstract. As Immersive Learning matures, and moves from the lab to the market, there is an increasing need to provide non-technical users with simple but effective tools. An especially important need is the development of tools that empower instructors and learners to create and interact with Units of Learning (UoL) in a simple (non-technical) way that promotes creativity and engagement. End-user programming is a paradigm that allows users to “program” a sequence of actions inside technological environments to customise them. In this particular case, we analyse the use of end-user programming applied to education from two different perspectives: the learner and the instructor. Both are considered end-users and they can both create “programs” inside our learning environment. In this paper, we extend our previous work towards the *InterReality Portal*, our collaborative mixed reality learning environment. The *InterReality Portal* applies Problem-based Learning (PBL), a constructionist student-centred method, and co-creative learning in the realization of mixed reality laboratory activities for learning computing fundamentals based on a combination of *xReality* and *Virtual* objects using end-user programming to produce creative *Internet-of-Things* computer projects using collaborative interaction between geographically dispersed students.

Keywords. End-user programming; mixed reality; dual reality; xReality objects; blended reality; virtual laboratory; learning design; co-creative learning; constructionism; problem-based learning (PBL); Internet-of-Things; embedded-computing; immersive learning; deconstructionalism; interreality portal.

Introduction

The arrival of the Internet has acted as a catalyst for distance learners to experience new technologies to enhance the educative process. Examples include videocasts through online programs to diverse virtual learning environments (VLE), virtual worlds and even virtual laboratories. The increasingly connected nature of our world is driving an ever expanding virtualisation of our lives one of which opens a range of opportunities to experience education outside the traditional classroom. One of these

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approaches is the use of immersive learning, a combination of interactive 3D graphics, commercial game and simulation technology, virtual reality, voice chat, webcams and rich digital media with collaborative online course environments and classrooms [1] that promote possible solutions to the problems of presence and engagement by allowing the learners to participate and interact as if they were sharing the same geographical location [2] [3].

In this paper, we extend our research towards the creation and use of virtual laboratories by combining *xReality* objects, *Virtual* objects and learning activities within our mixed reality collaborative learning environment. We introduce, briefly, the implementation and conceptual architecture of our work-in-progress test bed – the *InterReality Portal* – and explore the use of end-user programming in learning activities. Finally, we provide conclusions and identify challenges to be addressed in our future research.

1. The InterReality Portal

Current research on laboratory activities for distance learners is focused on simulations, virtual laboratories and remote laboratories where there is no interaction with real equipment and the activity is mainly performed with idealized datasets and restricted collaborative interaction [4].

In previous papers [5] [6] [7] we presented a holistic conceptual model – the *Mixed Reality Intelligent Learning* (MR-iLearning) Model – as a research context for an innovative learning environment – the *InterReality Portal* (Fig. 1) – that allows geographically dispersed students to collaborate on mixed reality laboratory activities using combinations of cross reality (*xReality*) and virtual objects.

Virtual objects are elements that can only exist in a virtual environment (e.g. a virtual learning environment (VLE)) and all its characteristics and properties are linked to the existence of the virtual environment. *xReality* objects are physical elements that have a virtual representation of them in a virtual world. The main characteristic of these objects is their *dual reality state*, resulting from the data interchange between the real world and the virtual world, as is mediated by networks of sensors and actuators [8]. Each object, in the real and the virtual representation, is complete by itself and can exist without the other, however the *dual reality state* enriches both objects by the bi-directional process that can reflect, influence and merge real-time information. The interaction between physical and virtual elements within an environment can be defined as Cross-Reality (*xReality*) [9].

The ability of users to perform real-time work within a Cross-Reality environment, by switching context between environments and blend traces of one into the other in a socially unconscious manner – often seemingly as simultaneously – is defined as Blended Reality [10]. This allows users to extend realities and combine them as if they were one, avoiding the “*vacancy problem*”. Lifton et al. defined the “*vacancy problem*” as the capacity of user’s *presence* and engagement to a single reality at a time. This is a consequence of the user’s real immersion. A user can be absorbed in a virtual reality, having a lack of *presence* in their local “*reality*” during this time and vice versa [11].

Presence is a particular psychological experience described as the sense of “being there”. Applied to collaborative environments, *co-presence* is defined as the sense of “being there together” with other geographically dispersed users [12]. Immersion can be defined as the objective and measurable property of the system or environment that encompass both the physical aspects of the environment and the psychological sense of *presence* [12]. This enables a different idea of immersion, as virtual reality and the real world would become one, people concentrated in a particular task within the blended reality could be considered as completely immersed in virtuality/reality at the same time and space.

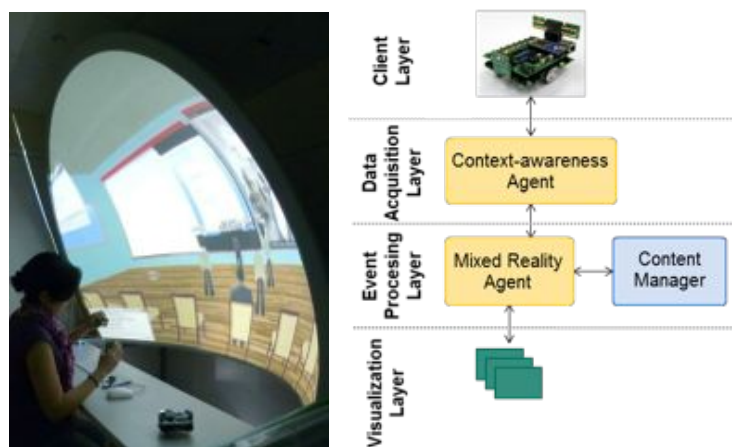


Figure 1. InterReality Portal (implementation & conceptual model) [5].

The learning goal of our mixed reality lab activity implementation is to produce *Internet-of-Things-based* computer projects grounded on co-creative and collaborative interaction between learners using problem-based learning (PBL), a constructionist method that allow students to construct their own knowledge by the correlation between concepts and proposed solutions to real world problems performed in realistic settings [13] [14].

1.1. Implementation

The implementation of the InterReality Portal is based on three major components:

- a) *A real environment*: To implement an immersive real environment we combine 1) a semi-spherical sectioned screen, the Immersive Displays Ltd.’s ImmersaStation², based on a specification from the sci-fi story “*Tales from a Pod*” [15]; 2) a camera that allows students to interact between them and the environment, 3) a network of sensors and actuators to obtain real-time information for object identification and replication for dual reality states. Although virtual worlds used on personal computers (PC) – “*Desktop Virtual Environments*” – introduce people to immersive technology, a Cave Automatic Virtual Environment (CAVE) provide a high-degree-of-freedom with the aid

² Immersive Display Group - <http://www.immersivedisplay.co.uk/immersastation.php>

of input devices and video tracking systems. Our implementation, the eDesk, delivers the characteristics of a CAVE and includes a desk allowing the user to be sit in a natural position to perform learning activities, with a free-range of head movement without the need of any intrusive body instrumentation (e.g. special glasses).

- b) *A 3D virtual environment*: Wann & Mon-Williams defined a 3D virtual environment as *an environment that capitalizes upon natural aspects of human perception by extending visual information in three spatial dimensions* [16]. For the implementation of the *InterReality Portal*, we use Essex University's MiRTLE project as our virtual environment. MiRTLE is a 3D-VLE that promotes teacher/student interaction for remote learners by linking a physical classroom with a virtual classroom providing an instructional educational setting [17] [18]. Created on Open Wonderland³, a java-based open source toolkit for creating collaborative 3D virtual worlds, MiRTLE provides some of the benefits of the use of virtual worlds in remote education such as social interaction and sense of presence and engagement within the class [2]. By taking MiRTLE as our 3D virtual environment, we extend its use from an instructionist 3D-VLE to a constructionist model for co-creative learning.
- c) *xReality objects and Virtual objects*: for the construction of mixed reality lab activities, we utilise Fortito's Buzz-Board Educational Toolkit⁴ (Fig. 2) [19]. This educational toolkit comprise 30 pluggable hardware boards that can be interconnected, and together with software modules can create a variety of *Internet-of-Things* applications [20] such as mobile robots, mp3 players, heart monitors, etc. The hardware boards allow discovery and identification via network events. The hub base board can be integrated with mbed microcontrollers⁵ or with Raspberry Pi⁶ – the low-cost computer able to work with Linux – improving the possibilities of creativity, ease of use and integration with diverse IDEs and end-user programming tools.



Figure 2. Fortito Educational Toolkit.

³ Open Wonderland Foundation - <http://openwonderland.org>

⁴ Fortito Educational Technology - <http://www.fortito.com/buzz>

⁵ Mbed - <http://mbed.org>

⁶ Raspberry Pi Foundation - <http://www.raspberrypi.org>

2. Co-creative Mixed Reality Learning Activities

Learning activities within the InterReality Portal are structured as a sequence of activities based on the IMS Learning Design specification. This sequence of activities – Units of Learning (UoL) – can be preceded by zero or more conditions before starting or completing the tasks [21].

In the implementation of our test bed, the learning objective is to build a computer science project combining hardware (xReality objects) and software modules (virtual objects) to create *Internet-of-Things* (IoT) applications emphasising computing fundamentals.

Figure 1 illustrates the conceptual model of the *InterReality Portal* and figure 3 exemplifies the interaction between system components when a collaborative *Virtuality Continuum Learning Activity* is taking place. In both, the *Context-awareness agent* (CA) identifies the object(s) (xReality or/and virtual), actor(s) and learning activity to be completed. Then sends this information to the *Mixed Reality* (MR) agent in the *Event Processing* layer. The MR agent obtains, from the *Content Manager*, a set of rules and behaviours available for the identified object. This information is sent to the *UoL Manager*, which constructs the sequence of activities in the UoL. Finally, the MR agent reacts by performing an action within the *Virtualization* layer. In the case of an xReality object creates a *single dual reality state*, a virtual representation of the change in the object.

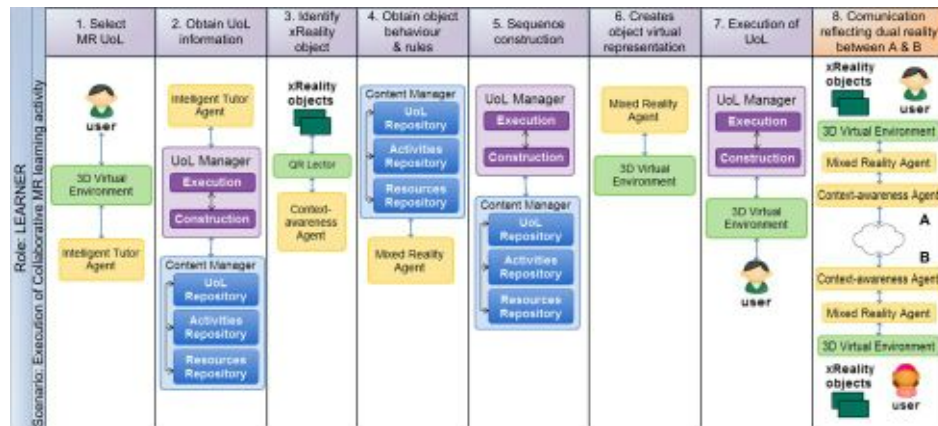


Figure 3. Execution of a Collaborative MR learning activity [5].

To perform a collaborative learning activity, after the establishment of a *single dual reality state*, the *InterReality Portal* establishes communication with other remote learners and creates a second representation of the event performed in the first environment, thus extending the *single dual reality state* to *multiple dual reality states* (Fig.3 & 4). As long as the session continues, changes in any of the objects will be managed by the Context-Awareness agent and the Mixed Reality agent considering the following scenarios:

- a) A change in any Virtual object of a given InterReality Portal results in identical changes to all subscribing InterReality portals.
- b) A change in an xReality object of a given InterReality Portal results in changes in the representation of the real device on all subscribing InterReality portals.

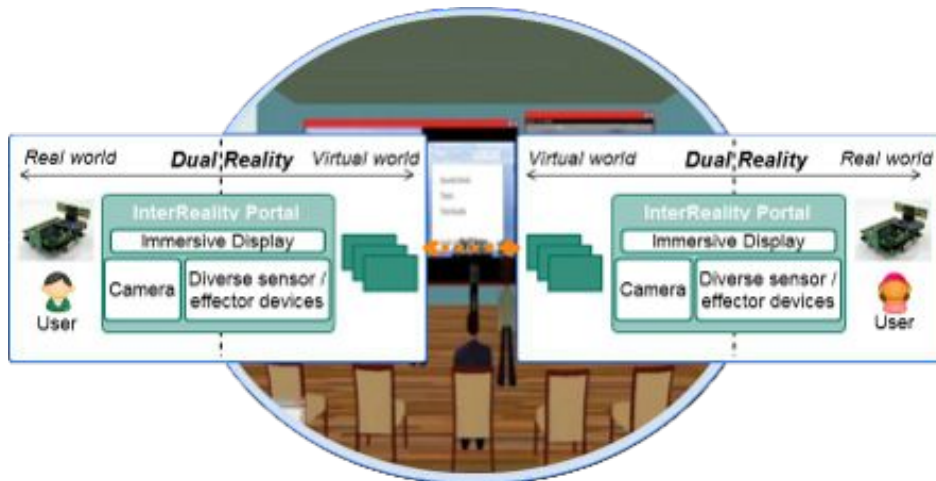


Figure 4. Multiple dual reality states [7].

3. End-user programming for Co-creative Mixed Reality Learning Activities

The interaction between users and the co-creative mixed reality learning activities can be analysed from two different angles:

a) From the learners view: During the learning session when they interact with the environment and between them, they are programming a series of actions to be executed by the objects.

b) From the instructors view: While they are creating a UoL, they are establishing a sequence of activities to be performed by the learners during the educational session.

In both cases, the learning environment should allow users to create and execute learning activities regardless their expertise on computers. Chin et al. [22] proposed a classification of rules to identify and separate the behaviour of different actors inside an intelligent environment: *pre-programmed rules*, *agent-generated rules* and *user-generated rules*.

Pre-programmed rules are usually created by the developers or manufacturers to define the properties and capabilities of the objects/services, in the case of our xReality object implementation these are the pre-programmed code inside buzz-boards or the properties assigned to each virtual/xReality object. *Agent-generated rules*, created from intelligent agents, artificial intelligence or machine learning mechanisms. These are the rules generated by the Context-awareness agent (CA) and the Mixed Reality agent (MR) when the user interacts with the environment (Fig. 1). Finally, *user-generated*

rules created by the users via end-user programming. These involve the creation of UoL by instructors and the execution of UoL by the learners to create Internet-of-Things projects. End-user programming can be defined as a number of techniques that allow non-technical people to create “programs”, which describe a sequence of actions to be performed by a particular environment [23].

To create *user-generated rules*, different approaches have been used to encourage and empower users to create programs. One approach is the use of drag-and-drop programming. In this, graphical representations of objects (e.g. an icon of a physical artefact), statements (e.g. an if-then-else conditional expression) and variables are transformed into concrete objects that the user can see and manipulate, *making them easier to understand through tinkering and observation* [24]. Some examples of this are MIT’s *Scratch*⁷, Carnegie Mellon’s *Alice*⁸ and Kent University’s *Greenfoot*⁹ in which users ‘assemble’ different objects and statements to create blocks that represent a form of algorithms without knowing logic programming or a particular programming language. The forms of each graphical representation allow only to assemble particular items in order to avoid errors due to grammar syntax.

Ko et al. identified six learning barriers, aspects of a programming interface that are prone to generate invalid assumptions and thus produce an error. These are: a) design (*I don’t know what I want the computer to do...*), b) selection (*I think I know what I want the computer to do, but I don’t know what to use...*), c) coordination (*I think I know what things to use, but I don’t know how to make them work together...*), d) use (*I think I know what to use, but I don’t know how to use it...*), e) understanding (*I thought I knew how to use this, but it didn’t do what I expected...*), and f) information (*I think I know why it didn’t do what I expected, but I don’t know how to check...*) [25]. A benefit of program visualisation is that frustration associated with debugging is minimized because students can directly map instructions to the result of what they see onscreen [26]. These “programming” environments are based on Papert’s constructionism theories and implement some of the ideas of Papert’s Logo, a computer language designed specifically for children [27].

A particular use of end-user programming tools is the possibility to create “programs” for diverse pieces of hardware to interact with the real world. Projects such as The Playful Invention Company’s Picoboard¹⁰, integrate visual interfaces for programming real-world prototypes. However, these solutions do not consider options for collaborative work for geographically dispersed students.

From the instructor point of view, the use of Learning Management Systems (LMS) – such as CooperCore¹¹ or LAMS¹² – could be considered as an end-user interface to implement the structural specification of IMS Learning Design into VLEs. We should remember that LMS also considers the learner’s perspective, by allowing

⁷ MIT Media Lab Scratch - <http://scratch.mit.edu>

⁸ Carnegie Mellon University Alice - <http://www.alice.org/>

⁹ University of Kent Greenfoot - <http://www.greenfoot.org/door>

¹⁰ Picoboard - <http://www.picocricket.com/picoboard.html>

¹¹ CooperCore - <http://coppercore.sourceforge.net>

¹² LAMS Foundation - <http://lamsfoundation.org>

them to perform UoL previously created by the instructor within the LMS environment; however, learning activities inside LMS environments currently do not consider the use of cross reality elements, therefore learner's perspective in LMS is not considered in our research.

Some work on the integration of instructor's perspective (LMSs in virtual worlds [28] [29]) and learner's perspective (end-user programming software [30] [31]) into virtual worlds has been done. Ibáñez et al. [29] explore the integration of LMS, mixed reality activities (using virtual objects) and collaborative activities, however the use of xReality objects mixing real objects and virtual objects to promote a co-creative learning process between a group of learners has not been explored yet. Additionally, the integration of end-user programming software with virtual worlds have been used to create collaborative simulations inside the virtual reality [31], available only in the virtual world.

Clearly, the combination of both perspectives in 3D Learning Environment could provide homogeneity and structure to the creation of mixed reality learning activities, adding collaborative learning [32] on xReality objects to current research on this area.

3.1. Using the Deconstructed model

One proposed solution is the use of the *Deconstructed* model. Based on the disaggregation of physical/logical devices and services, this model propose the creation/identification of a number of elementary services (atomic functions) which can be combined in various ways to create complex functions (nuclear functions) [33].

Deconstruction has been used extensively in education for teaching and learning. MacDonald [34] suggests considering teaching as dividable tasks, and proposes a model for deconstructing them into basic sections. Self explores [35] [36] the constructionist part of deconstructionism applied to learning computer science fundamentals. He explains that the deconstructionist perspective emphasizes that learning comes from differences between the model and the situation where it is applied, rather than from similarities, which the abstractions of rationalism emphasize.

In our work, deconstruction is used as a key learning principle of understanding and creation. Modularisation techniques – such as the divide and conquer perspective that involve recursively breaking down a problem into sub-problems until these become simple enough to be solved directly – are used in engineering to comprehend problems and design solutions.

Applying these ideas to the *Interreality Portal*, we identify from the instructors' perspective that the creation of UoL is based on activities (atomic functions) which can be combined to create nuclear functions (a complete UoL). From the learners' perspective the idea is similar, xReality and virtual objects (atomic functions) can be considered as part of a deconstructed set of components that students can reconstruct in any combination to generate their own unique xReality project – or to reconstruct a xReality project that is prescribed by the instructor – (nuclear functions). From a technical (system architecture viewpoint) the deconstructed elements become sets of autonomous networked resources, that may be inter-connected to form different

combinations (constructed) thereby forming a variety of student projects or UoL as required by the teacher or student. In practical terms each element is either a process/thread or a processor (examples being the BuzzBoard modules [20]), neatly solving the practical issues in implementing this model. Table 1 shows a correlation between these concepts.

Table 1. The *Deconstructed* model as an unification architecture for instructors, learners and technical infrastructure

Role	Atomic function	Nuclear function
Learner	Objects available in the environment, actions available (programming statements).	An Internet-of-Things project
Instructor	Resources available in the environment, activities available (sequence of activities).	A Unit of Learning (UoL)
Technical infrastructure	Processes, threads, processors or FPGA	xReality toolkit and system

Thus, from the above discussion, summarised in Table 1, *deconstruction is the essential glue, and enabling principle, that unifies the pedagogical and technical elements of our model.* In more detail, the use of deconstructionism in our collaborative mixed-reality laboratory architecture unifies a constructionist pedagogy (in which learning is a consequence of the correlation between performing active tasks that construct meaningful tangible objects in the real world and relating them to personal experiences and ideas), with a set of hard and soft objects in the form of BuzzBoards [20] and their supporting software (i.e. the networked atomic/nuclear functions comprising processors, logic and processes). Therefore, in summary, deconstructionism is the key element that unifies the physical model of distributed mixed reality objects with the pedagogical model of constructionist laboratories enabling the creation of a blended reality distributed system. In this view, xReality objects become deconstructionist architectures fitting both the constructionist pedagogy and a physically distributed architecture permitting the creation and execution of mixed reality learning activities within the *InterReality Portal*.

Summary and future work

In this paper, we have described a holistic immersive mixed reality learning environment, the *InterReality Portal*. Grounded on co-creative constructionalist PBS learning theories, the *InterReality Portal* offers the possibility of creating collaborative laboratory activities for geographically dispersed students. To support this, we have defined the learning environment (real + virtual), the technical core elements of our mixed reality activities (the *xReality* and *Virtual* objects) and explored combining them using end-user programming to create a type of educational mixed reality object.

In addition, we presented a series of challenges for constructing this model. First, the pedagogical challenge of using a constructionist student-centred method to create laboratory activities for distance learning. Secondly, a technical challenge of having a representation of a deconstructed world from two different perspectives: learners and instructors, defining a set of components that can be shared and combined (e.g. atomic

and nuclear functions in Table 1) and enabling the technical distribution of objects between different immersive environments to create a blended reality distributed system. Finally, the most important, the challenge of bridging the physical model of distributed xReality objects and the pedagogical model of constructionist laboratories to produce a solution for distributed mixed reality laboratories. To solve this we have proposed the use of a deconstructionist architecture that we have argued has the capability to glue a constructionist pedagogy seamlessly into a physically distributed (but logically holistic) immersive learning environment.

Considering future work, whilst our work to-date, as reported here, has made significant progress with the development of an architecture and supporting theory for the distributed immersive mixed reality learning model, which we hope is in itself a significant contribution, there is remains much for us to do to realise our full vision. Figure 5 summarises the implementation stages of our practical work. Phase 1 involves the construction of a functional InterReality Portal able to work with xReality and Virtual objects (detection, identification and management of a *single dual reality state*). Phase 2 explores the design and implementation of mixed reality laboratory activities from the learner perspective and the instructor perspective using Learning Design UoLs and end-user programming. Phase 3 extends our research to the management of *multiple dual reality states* between two or more InterReality Portals to create blended reality while the learners perform the learning activity in separate locations as described previously.

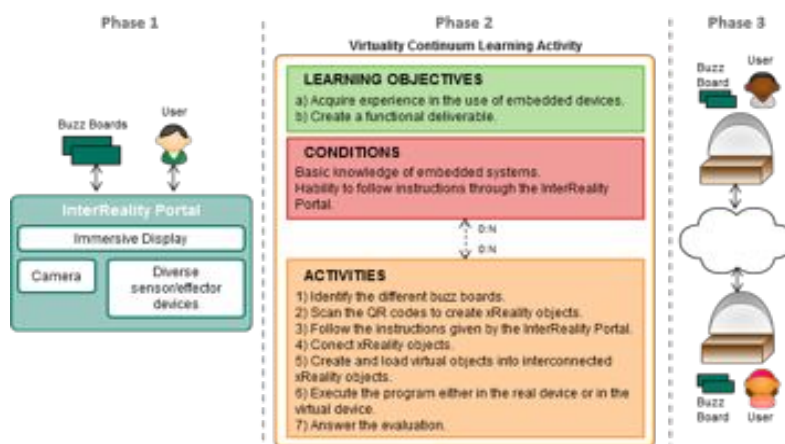


Figure 5. Implementation phases.

Thus, in relation to our future plans, Figure 5 shows that our research is moving from phase 1 to phase 2, integrating the *InterReality Portal* implementation with the end-user programming concepts discussed within this paper. The possibility of combining virtual and xReality objects with deconstructionism and the use of end-user programming to create mixed reality learning activities that can be constructed and shared by teams of geographically dispersed students is our final goal. This project has another two years to run and, over this period, we aim to gradually answer the remaining research questions set out in this paper, which we look forward to presenting in subsequent workshops and conferences.

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Understanding Physical Concepts using an Immersive Virtual Learning Environment

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Abstract.

Understanding basic physical concepts is not an easy task. The Technology Enabled Active Learning Approach (TEAL) is an innovative learning approach and successfully improves the conceptual understanding in teaching freshmen physics at the Massachusetts Institute of Technology. This approach requires specially designed classrooms, hands-on experiments, different teaching methods and also virtual visualizations and simulations to enhance the student's engagement and learning success. The Java-based open-source framework TEALsim was especially designed to support the students understanding of different physical procedures using visualizations and simulations of physical concepts such as Faraday's Law. But not every institution or university is able to use the TEAL scenario because of the high expense in terms of required equipment. Also the distance learning idea is lost. Existing learning spaces are limited regarding time and space. Depending on the learning scope and application domain conventional E-learning tools are not always the best choice. Especially such abstract domains as physics are hard to teach without advanced tools. Drawbacks such as the lack of immersion and the lack of communication and collaboration possibilities suggest the introduction of a new e-learning tool, the Virtual 3D World. This paper focuses on the technical aspects of the implementation of TEALsim in the Virtual 3D World Environment Open Wonderland. This collaboration between the CECI at MIT and AEMT group at TU-Graz introduces a first potential scenario of in-world physics simulations. The Open Wonderland solution in particular supports collaborative learning settings, and enables students to have pedagogical valuable discussions about the material being learned.

Keywords. TEAL, TEALSIM, Open Wonderland, Virtual TEAL World, Physical Simulations, E-Learning

Introduction

The Massachusetts Institute of Technology (MIT) uses the educational model known as Technology-Enabled Active Learning (TEAL) [2] to improve the conceptual understanding of students in freshman physics. The learning outcomes are supported by specially designed classrooms, relatively small numbers of students, and group activities and visualizations. Not all principles of physics can be explained in using

static two-dimensional images. Therefore the TEALsim [10] approach uses a three-dimensional simulation framework to enhance the student understanding and conceptualization of the physical phenomena. But resources in common educational environments are often limited and many of the needs of the students cannot be met as they are in the TEAL framework. We propose a virtual three-dimensional environment where students can meet in the form of avatars, can work together and discuss problems as they could in the real world, so as to extend the TEAL learning scenario to situations with fewer physical resources, and at a distance. This environment, the Virtual TEAL World, provides students the possibility to visit online learning courses and uses the TEAL learning approach to improve student understanding. This solution is a result of collaborative research between the Center for Educational Computer Initiatives (CECI) at MIT and the AEMT group at Graz University of technology. The results reported here are a continuation of the proof of concept work in 2009 [9].

Section 1 introduces the TEAL approach and states the advantages of Virtual 3D environments. Section 2 focuses on an overview of the integration of the TEALsim framework in the Virtual 3D World environment Open Wonderland [8] and introduces the implementation of the TEALsim Module. Section 3 introduces a potential scenario which uses the developed TEALsim Module. The TEAL learning approach is used to design the Virtual 3D environment Virtual TEAL World.

1. Background

This section will address challenges of science education and introduces in this context the TEAL learning approach. Due to different drawbacks of conventional e-learning tools regarding this teaching approach, the e-learning tools Virtual 3D Worlds will be introduced.

1.1. Science Education

Teaching science, especially conceptual domains such as physics have always been challenging. Students have to face challenges such as the imagination of invisible phenomena or the relation between the physical concepts and the corresponding equations. Research shows that hands-on experiments and experiences improve the student's understanding of the concepts, and also helps the student to retain the acquired knowledge for a longer period. Visualization and simulations of physical principles which are sometimes impossible to see, enhances the student's understanding. [3][9]

The Technology-Enabled Active Learning (TEAL) approach at MIT addresses these issues in that it provides a learning environment which includes not only hands-on experiments, but also visual representations and three-dimensional simulations of the physical concepts, especially in electromagnetism. TEAL combines oral explanation in class, technology enhanced experiences such as desktop experiments, two- and three-dimensional visualizations, web-based home assignments and conceptual questions using electronic polling devices, written problems such as home assignments or class workshops, and also traditional textbooks. The approach focuses on active learning in a collaborative setting; therefore a specially designed classroom (see Figure 1) is used. [3][10]



Figure 1. 3D model of the d'Arbeloff Studio classroom [10].

But not every institution or university is able to provide the required resources and funding to implement the environment required in the TEAL approach. Different E-Learning tools and systems can help in building up a similar, but much less expensive learning environment. But it is crucial that the collaborative aspects of the TEAL approach not be lost. The following section introduces Virtual 3D Environments as a means to support especially the collaborative aspects of TEAL.

1.2. Collaborative Learning in Virtual 3D Environments

Virtual 3D Worlds (VWs) such as Open Wonderland are receiving increasing interest from educational institutions. In particular the collaborative and social aspects can be seen as advantages of VWs in comparison to conventional E-Learning systems: Verbal and non-verbal communication channels provide students an optimized way to communicate, the feeling of presence in an environment increases the motivation, awareness of the environment and other users enforces the communication, three-dimensional objects such as whiteboards facilitate the collaboration, and learning content can be visualized [5][6].

The next chapter focuses on the integration of the simulation framework TEALsim into the open-source virtual world environment Open Wonderland. [8]

2. Integration of the TEALsim Framework in Open Wonderland

This section is mainly an overview of the integration of the TEALsim Framework in the Open Source toolkit for building 3D virtual world Open Wonderland (OWL) [7]. The entire section is based on Berger in 2012 where further implementation details can be found [1].

2.1. The Simulation Framework TEALsim

TEALsim is an open-source educational simulation tool, developed at the Center of Educational Computing Initiative (CECI) at MIT and focuses on the development, presentation and control of physical concepts. An example of this is the Falling Coil simulation [10], which is an example of induced currents described by Faraday's Law. As shown in Figure 2 the original TEALsim user interface consists of several parts:

1. A menu bar from which the user can choose a simulation. Additional items contain help and program control functionality.
2. A 3D window showing the spatial content of a simulation.
3. A simulation configuration window allowing the user to set simulation parameters and visualization options.
4. A simulation execution panel for starting, stopping, pausing, or reversing a simulation.

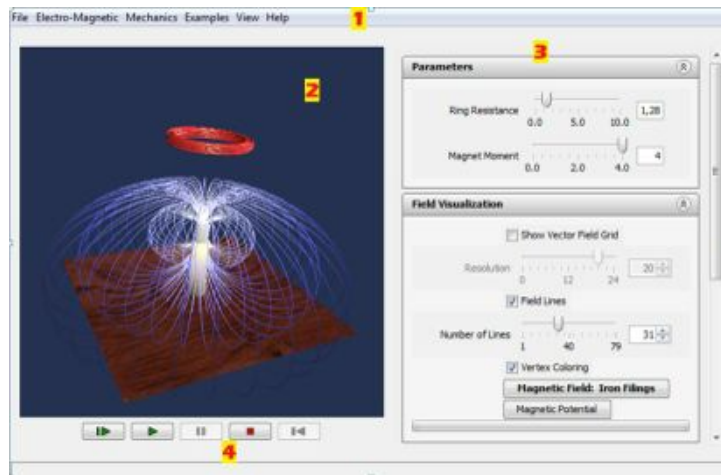


Figure 2. TEALsim desktop user interface showing the Falling Coil simulation

The simulation definition process can be performed by teachers with only moderate programming skills. This makes TEALsim easy to use for teaching personnel. The simulation definition interface consists of a tree of classes, each branch supporting a different type of simulations. To implement a new simulation one of these classes needs to be inherited. The simulations presented in this paper are inherited from the electromagnetic simulation class. In a simulation creation method TEALsim's simulation elements are assembled to a simulation. This involves setting physical values, such as the charge of the elements as well as specifying the elements in the configuration window. Additionally, the latter elements can be attached to physical values using routes. Such a connection of GUI elements to simulation elements allows the player to interactively influence the results of a simulation. A slider can, e.g., be provided to change the electric charge of an element during the course of the simulation. From the software developer's perspective, TEALsim is a desktop application written in Java.

Figure 3 shows the main components of the TEALsim software. The architecture follows the Model-View-Controller (MVC) design pattern. In a simulation, representing the Model according to the MVC pattern, the single simulation elements, such as 3D objects, are defined and created. The corresponding simulation engine is responsible for calculating simulation steps while the simulation is running. The SimPlayer represents the Controller and creates the components and represents the GUI. The Viewer displays the single 3D simulation elements on the canvas, using Java3D. Further implementation details can be found in Berger in 2012 [1].

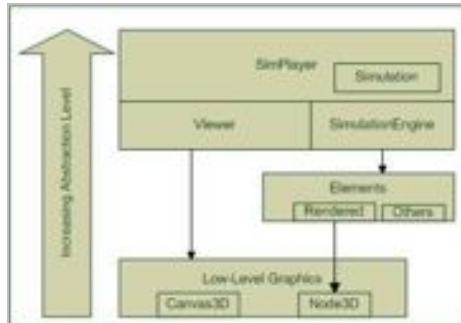


Figure 3. Main components of TEALsim [1].

2.2. The Implementation of the TEALsim Module in Open Wonderland

In order to use TEALsim within Open Wonderland (OWL), several adaptations to TEALsim were necessary. In particular, the lack of a client-server mode and the different 3D graphics library in TEALsim hinders the porting process. For the implementation several requirements on an abstract software-specific level were defined [3]:

- The integration of TEALsim into OWL should be performed in a generic way; No single simulations but most of the features of TEALsim should be ported. This way many simulations will run in OWL "out of the box".
- The simulation definition interface should be kept whenever possible. Many simulations already exist and people who define simulations often do not want to relearn the implementation process.
- The resulting software should be easily installable. OWL provides functionality to deploy modules on servers. For easy installation this functionality will be used.
- TEALsim should not entirely be converted into an OWL version. Instead, the core components will be used to build an OWL module. These improvements to the TEALsim components also affect the OWL module.

The stated requirements and the software design of the frameworks lead to three implementation steps.

Step 1: Adaption to OWL's graphics system

First, the 3D-graphics of TEALsim needs to support OWL's JMonkeyEngine(JME)/MTGame graphics system. Compared with Java3D, JME comes with more scene-graph primitives and with more support for loading 3D model formats, including those used by some TEALsim simulations. Additionally the MTGame game graphics system introduces threading support which had to be taken into account. Fortunately, TEALsim encapsulates low-level graphic elements such as scene graph objects and the 3D canvas. In order to support JME/MTGame in TEALsim, wrapper classes for these elements needed to be implemented. The Java3D support was kept and a mechanism was introduced to select the desired 3D implementation (that is, either Java3D or JME). When used with OWL the graphics output has to be set to JME/MTGame.

Step 2: Adding the client-server mode

The second implementation step is adding a client-server mode to TEALsim. How the components are split into client and server parts is influenced by many considerations. One possibility might be to keep TEALsim running on the clients only. This would require only minimal adaptations to TEALsim. However, keeping the simulations in sync between the clients is difficult with this approach. Simulation elements would have to be synchronized among the clients even without user interaction from time to time. Simulations can also include random values, which increases synchronization issues. Another possibility might be that the whole simulation is placed on the server and synchronization is only necessary on user interaction. Everything but the 3D rendering would happen on the server. This approach, however, has a major drawback. All data has to be transferred to the client. This includes the position data of the 3D elements. Some of them, e.g. field lines, are represented by hundreds of three-dimensional vectors. This is too much data to transfer over the internet.

Our approach combines the advantage of these two approaches and reduces the disadvantages. TEALsim's components are separated. Some are placed on the client, some on the server, and some are split into a client- and a server-version. This approach implies changes in some core components of TEALsim. The simulation is mostly running on the server side. This simplifies synchronization. However, visualization elements, such as field lines, which do not directly influence the simulation, are computed on the client side. This increases bandwidth utilization.

TEALsim's main components (see Figure 3) need to be split into client-side and server-side components. For easier synchronization the simulation definition object resides on the server. The physics engine, however, must be split into a server part and a client part. As stated above, most of the calculations will happen on the server. The engine is responsible for computing the next engine step, i.e., how the simulation elements change their internal physical parameters in a certain amount of time. Every engine step consists of several iterations over the simulation elements. Most of these iterations are performed as if we were running TEALsim's desktop version. The last phase is the computation of visualization elements, such as field lines. This phase happens on the clients. This requires the server to send the internal state of the simulation elements to the clients after each simulation step. Since the visualization elements are computed on the client they do not have to be sent to the client. For simulations which use visualization elements this saves a great deal of network utilization.

The engine is the component which is most affected by the additional client-server support. The implementation supports various engine types. In addition to the previously supported different engines for different fields of physics there is now an interface for different engine modes. The desktop mode is implemented in TEALsim whereas the client mode and the server mode are implemented in the OWL module. In order to support extending engine types for both, different fields of physics and different modes, the bridge design pattern described in [4] was utilized.

For obvious reasons the Viewer needs to reside on the clients only. While it holds a canvas in the desktop version, it will use OWL's canvas in the module version. Simulation elements representing the GUI of TEALsim are stored on the server. This is necessary to be able to send them to new clients after they log on. User interactions

mostly happen on such GUI elements. They are synchronized among the clients by serializing user events and sending them via the server to all other clients. This requires each element to have a unique identifier. Overall, TEALsim has been refactored to provide for extensions which will later be used in the OWL module. The desktop version does not suffer from a loss of features and uses the same simulation definition interface as before.

Step 3: Building of the TEALsim OWL module

The last implementation step is packing TEALsim into an OWL module and implementing the OWL-specific client-side and server-side components. The TEALsim-specific components are made using the newly defined interfaces of the TEALsim software. On the client side a specific Viewer is implemented by inheriting the general Viewer in TEALsim. Similarly, a SimPlayer is implemented for both, the client and the server components. OWL provides functionality to add module properties. We use this functionality to add support for switching between simulations. The user can simply right-click on the module, select the "Properties" entry in the menu, and select the desired simulation in the provided submenu.

3. Introduction of the Scenario ‘Virtual TEAL World’

The main objective of the Virtual TEAL World (VTW) is to provide a virtual learning environment that achieves learning outcomes as good as the TEAL environment. VTW is the attempt to design a Virtual 3D Learning Environment that integrates the educational valuable components and scenarios of the TEAL approach to provide a flexible, competitive and economic reproduction of the original TEAL environment. E-Learning Tools, Videos and the 3D-Simulations provided by TEALsim were adapted for the collaborative Virtual World Environment Open Wonderland to assimilate the original TEAL environment. The VTW focuses on enabling discussions, active participation and collaboration. The TEALsim-Module is used to visualize the simulations in the 3D space (see Figure 4).

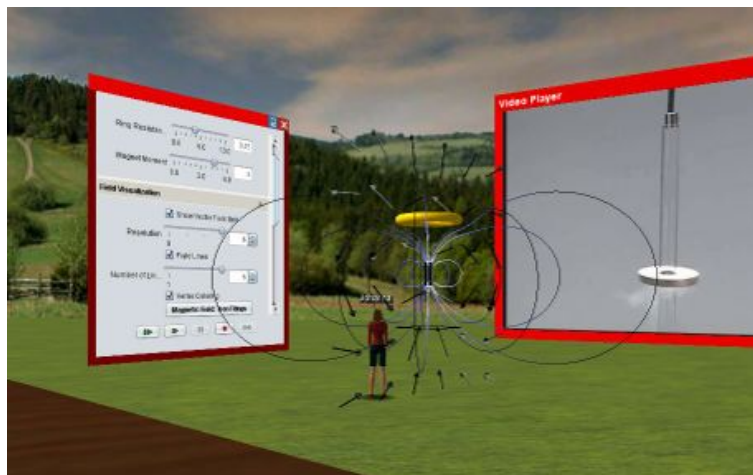


Figure 4. The TEALsim-Module showing the Falling Coil Simulation in the VTW.

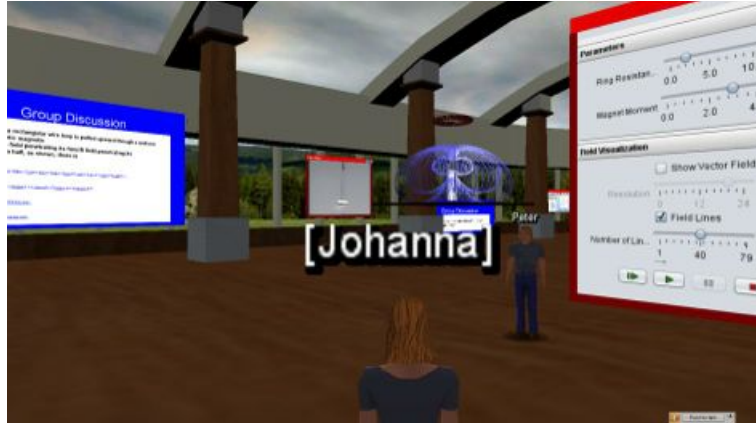


Figure 5. Overview of the Virtual TEAL World for Faraday's Law.

Figure 5 gives a glance of the VTW environment representing a single module focusing on Faraday's Law. Different areas of this environment address different TEAL learning approaches. The following table aspects are adapted from the TEAL approach and converted to an in-world solution [10]:

	TEAL environment	Virtual TEAL World
Oral explanation	In class	Videos and documents in-world
Collaborative learning	Groups of 3, with 9 students sitting at a round table and discussing electromagnetic phenomena.	A group of 3-4 students does a 'learning round-trip' in-world
Networked laptops	One for each group of 3, with data acquisition links to desktop experiments that students perform and analyze.	Desktop experiments are either simulated in-world or shown via videos
Multimedia visualization (TEALsim)	Media-rich Software delivered via class laptops and the Web.	3D representation via the TEAL module in-world (see Figure 4)
Course notes	With links to the visualizations.	In-world documents
Conceptual questions	Using Personal Response Systems	Using a special designed learning-module with an optional interface to a conventional e-learning tool

Table 1. Integration of the single TEAL environment components in-world.

4. Summary and Future Work

In this paper, we have focused on the advantages of using a Virtual 3D environment instead of conventional E-Learning tools in collaborative learning settings such as the TEAL approach. The Open Wonderland implementation of TEALsim gives students not only the possibility of watching and controlling the physical phenomena in a 3D space but also the ability to discuss the simulations in real-time together. The TEALsim-Module is still in development and in particular improvements regarding the performance, the usability and the client-server architecture are planned. The Virtual TEAL World tries to simulate the entire TEAL approach to provide learners not only a remote learning possibility but also a low-cost variant. The actual Virtual TEAL World is developed as a first showcase scenario and focuses on a single Faraday's Law module. Future development will include an evaluation of this scenario and also the corresponding adoption. After that, the VTW will also be introduced for other modules.

We believe that Virtual 3D Worlds such as Open Wonderland have great potential for supporting and also enhancing remote learning scenarios by adding motivational discussions and collaborative aspects.

Acknowledgement

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Getting Connected: Harnessing the Power of Social Media to Enhance Community College Students' Success

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Abstract. Today's college students have embraced social media/social networking sites. As such, social media has become a major part of their lives. These technologies are reshaping the way students communicate generally and within their college community. Despite the widespread use of social media, little is known about the benefits of its use in diverse contexts (e.g., community colleges) and for specific purposes (e.g., social, academic, and professional engagement of students). This paper examines *if* and *how* commuter-based community colleges attempt to use social media as a mechanism to increase students' connection to college. Using data from a social media platform—the *Schools App*—implemented in 9 community colleges across the U.S., we examine students' social networks and the content of the interactions in the virtual community. Findings reveal relatively low-dense social networks. Furthermore, findings show that the major use of the app seems to be to gain organizational and college-going procedural help and information – navigating the community college institution and their college pursuit more broadly.

Keywords. Social media/social networking sites, community colleges, college success

Introduction

In the past five years, SMT has transformed our thinking about our relationships, our connections with and affinity to other individuals, and even our ability to be persuaded by a collective on-line community to think, organize, and act politically. It was the entry of email technology, the internet, and then blogging into our personal and work lives that first began to shift our modes of communication toward on-line methods, but it was not until the creation of social media like Facebook, MySpace, Friendster, LinkedIn, YouTube, Twitter and other similar platforms that we have seen a massive harnessing of the potential of the now-pervasive on-line presence in our lives. Such social media has linked people together in ways that resemble traditional feelings of connection, belonging, loosely defined memberships, exchange of feelings and ideas, and the reporting of experiences and action that never before have so closely mirrored the idea of community as we understood and experienced it – or longed for it – prior to the existence of such technologies. Indeed, it is suggested that social media/social networking sites have suddenly lowered the costs of collaborating, sharing, and producing, thus bringing revolutionary new forms of interaction and problem-solving

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(Shirky, 2010). We can now create, maintain, and access both well-defined and amorphously defined communities on-line while also using the social media as a tool to fluidly transition between on-line and face-to-face contact via friendships, planned activities, and other more formal organizational affiliations.

The boundaries between on-line and “real-world” communities are rapidly deteriorating, particularly as we consider the generation of people for whom such social media exchanges have pervaded their lives. For this generation, social media is a primary means of communication and information-seeking, and possibly, a central component of their identity and community-building. Professor of Psychiatry at UCLA, Dr. Gary Small, suggests that these “digital natives”— young people born into a world of laptops and cell phones, text messaging and twittering — spend, on average, more than eight hours each day exposed to digital technology, and may experience fundamentally different brain development that favors constant communication and multi-tasking (Prensky, 2001; Small & Vorgan, 2009). Today’s college students have embraced social media/social networking sites. As such, social media has become a major part of their lives.

These technologies are reshaping the way students communicate generally and within their college community. Despite the widespread use of social media, little is known about the benefits of its use in diverse contexts (e.g., community colleges) and for specific purposes (e.g., social, academic, and professional engagement of students). As a matter of fact, only a handful of research studies (e.g., Ellison et al., 2011; Junco, 2011; Wimmer & Lewis, 2010) have directly explored the use of social media among college students. Unfortunately, the findings of those studies are limited in their capacity to offer solid sociological explanations for how some of our most vulnerable student populations, community college students, access social media to engage with and integrate into college communities. Consequently, it is critical to begin to examine how community college students are incorporating the use of social media into their college pursuits. Indeed, the most recent Community College Survey of Student Engagement (2009) found that the more students use social networking tools to communicate with other students, instructors, and college staff regarding coursework and other academic purposes, the higher their levels of engagement. There is no reason why postsecondary educators, and community colleges in particular, should not begin to explore the potential to intentionally and strategically harness the power of this revolutionary transformation to better serve the needs of students to enhance their success.

This project seeks to revisit social media at its roots – among college students – where Facebook first emerged. However, we move away from a focus on the elite institutions that birthed Facebook to the most non-selective postsecondary institutions – community colleges. As we imagine the “community” in community colleges today, the potential of an on-line social media platform is perhaps even more applicable. Community colleges enroll under-represented, commuting, non-residential students whose busy lives are often filled with family and work obligations (Bailey et al., 2004). They therefore tend to lack participation in the “campus community” of more traditional and elite students (Deil-Amen, 2011 and others). How can social media fill that void, and how can it be deliberately used by community colleges as a tool to engage students with each other, with the college, and with the college’s faculty and staff to create more of a “community” within a community college? Furthermore, can social media give these more disadvantaged college students access to the social capital and social networks (i.e., institutional connections and contact with other students,

faculty, and sources of assistance and information) that research has shown to enhance college outcomes? Researchers and higher education practitioners are well aware that when students connect with available accurate information, services, resources, and advising/mentoring relationships, benefits accrue. However, few understand how to get those students who need the most help to actually seek the help they need to strategize success. Social media is a particularly attractive option because it can cost-effectively bridge the important, yet severely limited, services of counselors and advisors, providing a potentially effective and exciting mechanism for catalyzing such connections for students.

1. Literature Review

As stated earlier, only a handful of research studies (e.g., Ellison et al., 2007; Junco, 2011; Mayer & Puller, 2008; Wimmer & Lewis, 2010) have directly explored the use of social media among college students. Why is existing research limited? First, the few empirical studies of social media that exist have examined 4-year college students (actually a minority of all college-goers) rather than community college student populations (now a majority of all college beginners). Second, only two of the studies (i.e., Mayer & Puller, 2008; Wimmer & Lewis, 2010) used data actually generated from social media sites rather than self-reported data on the use of social media. Finally, prior research has failed to engage the content of students' interactions and exchanges on-line.

Decades of research have shown that how engaged students are with their institutions (Kuh, 2001), how integrated they are into the social and academic life of the college (Thomas, 2000; Tinto, 1993), and how involved they are in the campus community (Astin, 1984), are all associated with various positive academic outcomes, retention, and degree attainment. In addition, a large number of empirical studies support the idea that relational constructs, such as "social capital", "social support", and "social networks" influence educational outcomes relevant to college (for a review, see Deil-Amen, Rios-Aguilar, & Rhoades, 2009). At the heart of this claim is the notion that social interactions are a crucial component of the educational experience of college students. However, few researchers have studied these dynamics and how they are relevant in the context of social media, and no research, to our knowledge, has applied these concepts to community college populations.

New conceptual models are needed to better understand the dynamics of how connection to college happens for non-traditional, commuter, and community college students, especially in on-line environments. Aspects of traditional frameworks, such as the concept of integration, are still relevant but operate differently for community college students (Deil-Amen, 2011, 2010; Tinto, 1993). In particular, in contrast to prior studies of four-year residential students, Deil-Amen (2011) discusses alternative types of socio-academic behaviors that challenge the dichotomous notion of integration occurring along purely academic or social lines. These "socio-academic integrative moments" are events, activities, interactions, and relationships in which academic and social elements combine simultaneously to enhance learning, procedural knowledge, information-acquisition, intellectual competence, college identity/belonging and connectedness. Routinely, these moments occur within and just beyond the classroom, often the most common place where commuting students meet other students and

instructors, develop feelings of belonging and engagement, and learn success strategies (Hughes, Karp & O'Gara, 2009).

Despite the fact that use of social media is near-universal for those under 30 years-of-age and actively utilized by nearly two-thirds of those under 50, we know almost nothing about the relevance of social media interactions for engagement, integration, belonging, college identity, or college community-building among community college students (see Davis, Deil-Amen, Rios-Aguilar, & González-Canche). For example, are the integrative interactions social? academic? socio-academic? What forms of social capital do such exchanges transmit? Our study applies theories and concepts previously found relevant to community college students to analyze their actual social media data. From this vantage point, we examine how their on-line exchanges reflect efforts by students and institutional agents to seek, offer, and engage particular forms of “integrative community building” and various social capital exchanges. Specifically, we focus on: 1) the foundation of Tinto’s concept of integration – a sense of identification or congruence with a college academic or social realm or community; and 2) forms of social capital related to group membership/belonging (Bourdieu, 1986), trust and obligation (Coleman, 1988), information-acquisition and exchange (Coleman, 1988), and access to network-embedded resources (Lin, 1999).

Taken together, our approach attempts to explore *if* and *how* community college students use social media to create for themselves virtual communities in the absence of the campus-communities more readily accessible to full-time residential, traditional four-year college students. And we qualitatively explore the kinds of community they are attempting to create. Examining what the students do in social media space provides a window into not only their definitions of community, but also the parameters by which they desire to build community, integrate into that community, and exchange social capital in the process.

2. Conceptual Framework

An adequate conceptual framework has yet to be developed that can help us examine the role that on-line communities play in community college students’ integration to a networked college community, for that reason, this study draws on two conceptual frameworks to analyze the data and to interpret the findings: (1) social network theory and social capital, and (2) networked individualism.

2.1 The Theory of Social Capital

Social capital is comprised of contacts and memberships in networks which can be used for personal gain (Bourdieu, 1986), and it is typically thought of a resource that individuals exchange and accumulate (Bourdieu, 1986 Coleman, 1988). Lin (1999) defined social capital as embedded resources or assets in social networks. These definitions emphasize the crucial role of creating and sustaining relationships with many different individuals to improve access to resources and/or to attain certain educational and occupational outcomes (Rios-Aguilar & Deil-Amen, 2012). Social capital has become very prevalent in higher education research, particularly within studies that focus on college access, persistence, and success. The breadth of the social capital concept reflects a primordial feature of social life, namely, that social ties of one kind (e.g., friendship and co-workers) often can be used for different purposes (e.g.,

advice, information, and decision-making) (Adler & Kwon, 2002). Researchers have criticized the theoretical use of social capital (e.g., Adler & Kwon, 2002). In particular, it has been argued that social capital is an aspect of social structure. Unfortunately, the social capital literature tends to attribute the phenomenon to individuals, often ignoring how social structure variation may affect social capital (Sanderfur & Laumann, 1998). Therefore, researchers should pay closer attention to students' existing social networks and to the social structures that constitute social capital—the location and patterning of a student's social networks in a larger social space (Granovetter, 1973).

2.2 Social Network Theory and Analysis

The use of the social network paradigm to understand human social group and societal behavior is not new. It figured prominently in Durkheim's (1951) groundbreaking study on suicide. The idea behind this paradigm is that individuals are linked to each other through a collection of social network ties that structure larger societal patterns of relationships and that these ties shape how individuals identify and define their membership in groups, communities, and societies, and ultimately shape action. Social network analysis, then, is the study of the patterns within a social structure. Wellman (1983) argues that social network analysis goes beyond a simple visualization of relationships: "Network analysts search for deep structures - regular network patterns beneath the often complex surface of social systems. They try to describe these patterns and use their descriptions to learn how network structures constrain social behavior and social change" (p. 157).

2.3 Networked Individualism

A recent report titled *The Strength of Internet Ties* (Boase, Horrigan, Wellman & Rainie, 2006) found that the Internet and email aids users in maintaining their social networks and provides pathways to help people make important decisions. Furthermore, the report provides evidence to support the idea that social relationships and community are not fading away in America as a result of the increased Internet use. That is, instead of disappearing, people's communities are being re-configured and transformed (Boase et al., 2006). The authors explain their findings using the concept of networked individualism, also known as individualized networking: "Rather than relying on a single community for social capital, individuals often must actively seek out a variety of appropriate people and resources for different situations" (p. 6). The concept of "community" is re-defined as "networks of interpersonal ties that provide sociability, support, information, a sense of belonging and social identity" (Wellman, 2005, p. 53). According to Wellman (2005), there are unique on-line dynamics in community- building:

"...the tendency for contact to be between two persons rather than within groups, folding-in of two disconnected friends into the same conversation, sending personal messages to participants in online discussion groups, typographical conventions of embedding interleaved responses inside original messages, using emoticons such as ";-)", and typing responses at the top of a series of messages rather than at the bottom (p. 54)"

Furthermore, Wellman, Quan-Haase, Boase, Chen, Hampton, Diaz and Miyata (2003) argue that this change is not only occurring at the interpersonal level but at the

organizational, inter-organizational and even the world-systems levels. It is the move from densely-knit and tightly-bounded groups to sparsely-knit and loosely-bounded networks. Wellman developed the concept of *networked individualism* to explain how the internet has re-shaped the notion of “community.” Wellman, Boase, and Chen (2002) argue that the on-line relationships add to existing face-to-face and telephone contact. Rather than increasing or destroying community, these newly created on-line relationships can best be seen transforming community such that it becomes integrated into rhythms of daily life, with life online integrated with offline activities. Wellman and his colleagues studied the Internet and its effects on communities generally and access to social capital. However, we argue that their concept can be used to examine also how social media is affecting the configuration of social networks specifically among community college students.

3. Methodology

As part of a grant-funded intervention, beginning fall 2011, eight rural, urban, and suburban community colleges serving several high poverty communities and located in multiple states (Arkansas, Arizona, California, New York, Ohio, Texas, Wisconsin, and Wyoming) were selected to adopt a Facebook-based application for use only by invited students, faculty, staff, administrators. The *Schools App* is purposefully designed to host, manage and facilitate *social engagement* for newly admitted students.² This *Schools App* creates a private proprietary community for students attending a specific college that allows them to: (1) make friends: the friend matching algorithm shows students people like them (based on their hometown, high school attended, hobbies, etc.), (2) ask questions and share interests: students can post questions and/or stay o top of trend conversation on the college’s wall, and (3) get involved: the meetups system gives students a way to get involved, meet people on their own terms, and organize social activities off-line.

3.1 Data

Data for this study comes from two primary sources: (1) Schools App, and (2) institutional data. More specifically, the Schools App data contains the following information: student id, date when student joined the on-line community, number of posts the student has made since s/he joined, number of communities the student has enrolled since s/he joined, total number of Facebook friends, total number of friends at school, the student id of friends, the affiliations (e.g., interests, hobbies, etc.) that the student belongs to, and the role of he participant (i.e., student, faculty, and/or administrator). We also have access to the nature of the on-line interactions of the students in the Schools App. To be more specific, we are able to “observe” what exactly has been posted on the Schools App wall by students and faculty. The institutional data includes students’ demographic characteristics including, race/ethnicity, age, remedial and enrollment (i.e., part- and full-time) status.

3.2 Data Analysis

² For details about the *Schools App* go to: <http://www.inigral.com/howitworks/>

Overall, we engaged in three stages of analysis. The first stage involved the use of descriptive statistics to learn about the overall characteristics of the on-line communities. The second staged involved a social network analysis (SNA) of the friendships created through the Schools App to identify patterns of relationships between people in the social network. Two key characteristics of an individual's social network are density and centrality. Density provides a measure of the overall connections between the participants. Social network theory suggests that the more participants connected to one another, the higher will be the density value of the network (Scott, 2000). Centrality is a measure that provides us with information about the behavior of individual participants within a network. Centrality indicates the extent to which an individual interacts with other members in the network (Wasserman & Faust, 1997). Using this measure, we can uncover who, for instance, is an important or influential member of a particular social network.³ The final stage of the analysis involved the coding and analysis of the text of students' on-line interactions. The text of postings on the Schools App were entered as data into *NVivo 9*, a qualitative analysis package, to facilitate the mechanics of the analysis. We then analyzed the data both inductively and deductively (Coffey & Atkinson, 1996) to generate original coding schemes. Modified open coding (Strauss & Corbin, 1998) took a grounded approach but was influenced by social capital and integration, involvement, and engagement theories. Then axial coding (Glaser & Strauss, 1967) was used to create structured rankings of concepts and sub-concepts followed by selective coding to help identify the most prominent themes patterning the on-line interactions.

4. Findings

Preliminary results indicate that, on average, across all participating community colleges, 14% of students have joined the virtual community. The percentage of students accepting the invitation to join the virtual community ranged from a high of 21% (at a large, urban community college) to a low of 7% at two large suburban colleges). Data also reveals that students have created an average of 2.6 friends on the app. Furthermore, we found that students have joined, on average, 18.32 communities. We also found that students are actively using the app as a place to “compensate” for shortcomings in the institutional context. Finally, findings show that the major use of the app seems to be to gain organizational and college-going procedural help and information – navigating the community college institution and their college pursuit more broadly.

4.1 Social Network Analysis

The measures of density are, on average, 0.0045. This value indicates that students are, indeed, making on-line connections however, as seen on Figure 1 not all students are connected to each other. Specifically, look at the outside of the circle, there are many dyads and triads that are *not* connected to the rest of the network. In other words, there seems to be sub-groups within all community colleges' on-line networks. It is important to state that values of density range from zero to 1. Therefore, the social networks of community colleges that participate in our study could be characterized as

³ All SNA were conducted in R.

low-dense networks. According to existing research on SNA, there are both positive and negative aspects to network density. The “constructive side” argues that high density is a sign of network closure. Closure is hypothesized to increase conformity to norms, resulting in greater trust between the members of the network. Closure and trust, according to Coleman (1988), are important forms of social capital. The “dim side” of density is that a highly dense network structure potentially limits the diversity of information that enters a community, as well as an individual’s freedom to pursue ideas and actions outside the norms of the community (Maroulis & Gomez, 2008). According to Burt (1992), social capital is equated with the lack of ties among an actor’s alters, a condition he names as structural holes. Further analyses indicated that a high proportion of students who are “central” in the networks are full-time and White. These figures indicate that the students who are creating more friendships (or are more powerful in network terminology) are first-time college students, who are more traditional, at least in terms of age.

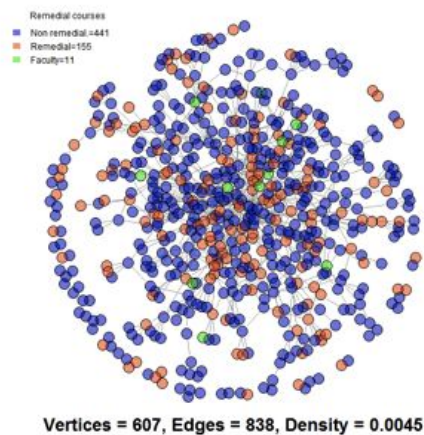


Figure 1. Example of the Social Network of the Virtual Community Created Through the *Schools App* at a Community College.

4.2 Content of Exchanges in the On-Line Communities

Several clear patterns emerged in our analyses, and each is introduced below.

- Prominence of academic language in this social media space

In the app posts, there is an overwhelming prominence of words like “class” “math” “take/taking” and “good.” In fact, “class” is one of the most frequent and central words in all the colleges. Content analyses reveal that posts and comments using these words tend to relate directly to academic course-taking. The word “class” is less prominent only where words more relevant to degree requirements are more utilized. “Good” is used to discuss and recommend particular instructors. Attempts to be purely social with college-mates did exist, but they did not dominate the postings as did the academic exchanges. Evidence of the informality of social exchanges is the frequency with

which typical informal “lol” “haha” “everyone” “hey” and “awesome” appeared in the text. However, content analysis shows that these often appear in academically-relevant exchanges, suggesting a more socio-academic nature. Attempts to socially integrate in more traditional ways proposed by existing models did exist but were much less active, such as sports activities, student organizations, or political and religious statements and conversations.

- Prevalence of questioning

Across the board, questioning words, such as “what” “how” “when” “does” “who” appear quite prominently, indicating students are using the app to ask questions and seek information. Content analyses revealed that frequent use of “any” “anyone” “know” “looking” “need” and “help” occurred among students seeking assistance or requesting something from each other, often for help about their classes or other academically-relevant issues. The effectiveness of the app in providing a forum for this social capital questioning, information-seeking, and mutual exchange of assistance can be seen in the prominence of words like “please” and “thanks.”

- Preference for self-identification by campus location and program/major rather than other demographic characteristics

In the app exchanges, there is a conspicuous absence of words representing race/ethnicity-based affiliations. Instead, students self-identified by reference to campus locations, and to a lesser extent, cities/towns (which appear smaller but which content analyses revealed as important for identity). Students also frequently sought to identify others in the same classes or identify as pursuing specific major/career interest. The latter words are not as common because there’s greater variety in these options (“business,” “health,” “computers”). Interestingly, words relating to transfer or four-year colleges/universities did not predominate.

- Financially-based, market-based, procedurally-based, and socio-academic nature of social capital pursuits

The app is a popular place for student-student asking/ answering of financial aid or procedurally-related course enrollment and other questions relevant to navigating the organizational aspects of college-going. Questioning words noted above are often related to these topics. Also, use of the app as market for buying and selling “books” and related supplies is extremely common among enthusiastic students “looking” for and offering books. In this way, students routinely exploit the opportunity the app provides to socially engage in actual market “exchanges.” When posts were further content-analyzed, the longer posts related to procedural or financial questions, help-seeking, book buying/selling regularly transformed into more personal/social exchanges. For instance, book transactions turn into sharing which majors they are pursuing and how they balance family and school, or questions about financial aid turn into expressions of frustration and discouragement followed by words of support, advice, and shared experience. Often simple posts seeking answers to specific questions turn into opportunities for other forms of socio-academic and procedural information-sharing that represent the type of “integrative community building”

relationships students seek to construct in this on-line space.

Furthermore, some interesting diversity exists across the nine colleges in the relative presence and specific manifestation of each of these four elements. We find the actions of administrators and staff shape interactions and student-use of the app in two key areas – students’ pursuit of financially-based and procedurally-based capital. For example, the financial aid administrators and office staff at one college keep an active presence on the app., consistently providing feedback to student questions regarding their financial aid and related procedures and inviting students to call or email for more personalized help when necessary, giving the exact person and number to call. Therefore, students in this college engage in a higher frequency of posts with financial language, demonstrating their greater use of the app for this purpose. In another college, a very active work-study student/staff answers procedural questions and offers links to further “information” on “degree” and other “requirements.” However, even absent proactive staff or faculty, students use their resourceful tendencies to forge their own socio-academic interactions in order to bolster their social capital. Students are choosing to fashion college community in a way that is most meaningful for them – a community dominated by interactions among community members open enough to expose their need for help with college procedures and academics and generous enough to respond with mutual advice, assistance, information. Students do not appear to be attempting to construct on-line college communities that reflect the strong family or racial/ethnic or neighborhood communities in which they already participate. As Yosso (2005) suggests, these pre-existing intact communities may be functioning for students already. Therefore, the on-line space exposes gaps in social capital and reveals how students compensate by activating their strong navigational capital to build a community through which they can acquire the specific other forms of social capital (academic and procedural) they may need to succeed.

5. Discussion and Implications for Further Research

Our findings suggest that networked individualism makes sense for the context of community college students’ off- and on-line interactions. That is, since most community college students live in communities off-campus, then they are likely already quite embedded in pre-existing off-line networks that include connections with family and friends, and with co-workers and other community members. Furthermore, this study takes what we know from prior research about the dynamics that can enhance persistence for community college students and translates it into a social media space to examine how community-building happens virtually. We’ve outlined four elements that may serve as building blocks for a more useful model of what contributes to persistence and other measures of success for community college students.

Findings suggest, when given a tool to do so, students gravitate toward forging socio-academic connections more readily than purely social relationships. We observe students acting in a way consistent with “cultural wealth models,” which emphasize how racial minority students draw upon their existing cultural/racial/ethnic resources to navigate successfully in dominant institutions. Oppressed communities, first-generation and students of color have been shown in prior research to rely on the socio-cultural components of social capital—community cultural wealth and funds of knowledge (Cammarota, Moll, Cannella, & González, 2010), including the ability to resourcefully

“navigate” unknown institutions in the dominant culture (Yosso, 2005). Our study shows these racial/ethnically diverse, low/mid-SES students activating their pre-existing “navigational” capital by resourcefully and pro-actively using social media space to expand their academic and procedural capital with, but mainly without, the benefit of direction from college leadership. Students are pro-actively attempting to create on-line communities rich in mutually beneficial, socio-academic, financial, and procedurally-relevant exchanges that can potentially enhance their college-going success, even in the absence of traditional forms of social integration and racial/ethnic identification.

Consequently, future research should examine in more depth: (1) the type of ties created, (2) the meaning, purpose, and function that students ascribe to these friendships and on-line interactions, and (3) whether or not the creation of “friendships” is related, in some way, to community college students’ academic outcomes (i.e., persistence and graduation). Such an approach can be compatible with traditional frameworks used to study persistence and attainment if researchers are willing to first observe and collect data on how community college students describe and seek out their own self-defined need for community and connection – both on and off-line. Only then can a more useful paradigm be developed for how such behaviors, connections, and interactions can facilitate success outcomes. In some respects, community college students may resemble more traditional residential students, but in other respects they may differ drastically in the nature of the “community” they desire either on and off-line.

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Augmented Edutainment on campus

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Abstract. ELTE University Faculty of Informatics has strong intention to bring life into the otherwise traditional theoretic approach of teaching and convert the environment into a student-centered enjoyment-based learning space. University campus thus becomes a live demo spot for ideas to explore, raise motivation, enjoy, and attract partnerships with museums for interdisciplinary project developments. In this paper we introduce projects installed at campus using QR/AR technologies, in the broadest sense, to set up informal learning environments that could be well applicable in museums and in the city. The IP4ET (Interactive Poster for Exploring & Testing) exhibits are examined in depth and the positive user experience that could indicate similar experiences at museums are being explored further.

Keywords. museums, social media, interaction technologies, augmented reality

Introduction

We are witnessing a huge gap between those who intend to teach and those who intend to learn, for one thing due to the age gap (teachers mainly belong to the elder generation, especially at universities, while students are massively members of the Net generation), the rushing pace of technological development (making the elders feel cast out, while making the younger's demand technology rich learning activities), and new pedagogical methodologies emerge in parallel (albeit the teaching generation encountering only traditional teaching methodologies). While technology is spreading quickly, and mobiles are becoming smarter than ever, there is a real challenge in how to harvest the emerging technological possibilities to enrich the learning process [1, 2].

Mobile games are catalysts for more interaction, creativity, and critical thinking in learning and while augmented reality (AR) is really appealing to the new learner it is also easier to use than other 3D technologies, providing integrated campus services [3], tour guides to museums, AR games, learning projects, smart objects [4] and lots of other museum AR goodies [5]. These projects surely challenge the traditional educational paradigms, while mobiles are more at hand than any computer technology before, allowing access at an early age, changing the way kids learn, giving space and sense to explorations [6]. Possession of such technology produces fluency of use, enhances digital literacy, computational thinking, and knowledge of technological background. Thus careful design is needed for mobile educational games in order to make learners engage in formal or informal learning processes using technology [7].

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²http://en.wikipedia.org/wiki/QR_code

1. Rationale

Universities in Hungary are more or less using ICT in a broad sense as a tool to facilitate learning, assessment, student management, in cases even leaning towards blended learning, yet holding tightly to traditional pedagogy. The vast majority of teachers are immigrants in the Info Communication Society, while the students are established members of the Net generation, with all its virtues concerning ICT use and networking and also flaws in terms of being attracted by flashy technology rather than traditional lectures and text-books. Yet, the Faculty of Informatics not only has to teach Computer Science in theory, but also has to use it in order to show its value in suitable applications that not only facilitate better learning processes, but also motivates learning and elevates its significance within the world of entertainment. Ideally, we should find 21st century methods to engage the Net generation in learning science, enjoy and think creatively and become a conscious entrepreneur in their own field.

Museums too cannot ignore the phenomena of technological developments, and the change of learning and communication habits of the Net generation, exploiting new possibilities with more or less success only, due to lack of resources and expertise. 2011 Horizon Report [4] Museum Edition pinpoints an urge for using mobile apps, augmented reality and smart objects:

“The abundance of resources and relationships made easily accessible via the Internet is increasingly challenging us to revisit our roles as educators.” [4]

This statement brings educational institutions and museums onto common ground in finding innovative ways for informal learning to become an enjoyable activity, not forgetting to utilize guidelines that are required to consider to follow in case of museum environments described by the following words: educational, persuasive, casual, but also purposeful, focusing on the response of the gamer [8].

Although the ownership of mobiles is indeed increasing and “smartness” is expanding among platforms, equity still remains an issue that needs to be solved as the critical limitation, which so far could prevent museums from relying on technology brought in by the visitor themselves [9].

2. IP4ET posters and services

It is a custom at our Faculty to display in the corridor posters that were presented at recent conferences so that students while waiting on spot can engage themselves by acquainting themselves with projects and thus consuming information about research at the faculty. Recently we produced extra media to extend the pictures on the posters and thus made the inquiry more enjoyable, combining art with technology in form of interactions as an extra add-on dimension to the posters. We actually call them IP4ET (when read aloud could refer to Internet protocol for E.T. - the Extra-Terrestrial) however IP4ET is really the short for Interactive Poster for Exploring & Testing.

These posters show a typically well applicable form of learning interactive media, which can be produced and re-produced very cheap as an artistic poster, yet it can also contain media elements not viewable other-wise. These could be well used in class, in corridors (see Figure 1.), in the streets or gardens, at museums, public transportation spots, health institutions or even office spaces. Their role is to engage viewers to explore (while awaiting for others or an event to begin) aesthetics, informative content, and the technological overlay:

- QR (Quick Reach) codes², leading to links on the Internet, providing further information or media on a topic. Any QR reader works well on most of the smart phones.
- “Take away” QR codes allow downloading the poster and examining further links positioned on the different sensitive areas of PDF files.
- QR codes could also be designed in an artistic form to contain extra visual information as aesthetics. They can be damaged in part to add elements of art, the know-how of which can be found in our course material (<http://matchsz.inf.elte.hu/VVprojekt/qrcodes.htm>).
- QR codes could also behave as AR (Augmented Reality³) markers, which could be overlaid by media elements (text, video, 3D object) using popular technology (Junaio⁴, Aurasma⁵, ... etc.). And also photos suitable for natural feature tracking could be used as markers for these services.
- GPS defined Points of Interests could be gathered into open services (like Hoppala⁶) to provide XML database for AR applications (Junaio, Aurasma, Toozla⁷, ... etc.).
- Junaio’s LLA⁸ codes (based on Latitude, Longitude and Altitude) can be used as in-door navigation markers.
- Any highly interactive Web 2.0 service that allows immediate access without subscription and provides immediate feedback automatically, without any further intervention could be used as mashups to developed applications.
- AR games, applications and simulations allow further dynamic exploration of pictorial elements on posters.



Figure 1. Explore our IP4ET corridor on Prezi: <http://prezi.com/xt3xczzaokm/elte-ik-tt-lab-ip4et-sarok/>

² http://en.wikipedia.org/wiki/QR_code

³ http://en.wikipedia.org/wiki/Augmented_reality

⁴ <http://www.junaio.com/>

⁵ <http://www.aurasma.com/>

⁶ <http://augmentation.hoppala.eu/>

⁷ <http://www.toozla.com/>

⁸ <http://www.junaio.com/develop/docs/documentation/general/location-based>

3. Cases studies of some posters developed

The T@T lab (<http://tet.inf.elte.hu/>) at ELTE University undertakes a course in Designing Interactive Media providing collaborative project work for interdisciplinary studies attended by students of all levels (B.Sc., M.Sc. Ph.D.) and disciplines (Arts, Computer and other Sciences) which is now focused on developing interactive installations that could be used both at university or at museums. Remarkable products have already emerged from such collaborations [10].

3.1. *Are You Smart – how to use posters*

This starter poster (Figure 2 A.), placed at each entry point of the building, takes users through a process in determining the qualities of their personal phones, how to download needed applications and adjust channels used as well as provides background information on the basics of theory and technology to be used while exploring posters. In fact, a full semester's course material is integrated within a single poster!

3.2. *Navigation/orientation*

As the university campus is quite huge, dispersed on several spots within our capital Budapest, it is rather difficult to find the different buildings, the right room and facility, staff member within buildings, thus we decided to provide virtual services to help people find their way (Figure 2. B.):

- We created a channel on Junaio, which helps navigation among buildings and facilitates in-door positioning with LLA codes on posters.
- All staff rooms are labeled with QR codes leading to the web page of staff members providing information on contact details and other relevant notes.
- All labs and lecture halls are labeled with QR codes leading to the web page of their weekly schedule and related arrangements.
- An in-house application reads QR codes providing orientation by showing a map of “where-you-are” and buttons to filter search information, plus a database where rooms or staff members could be searched for.

3.3. *Engaging the spirit of ELTE University on spot*

Further posters to engage students with the past and present of our university:

- A poster inquiring who could have been a student at our 377 year old university, providing QR text-to-speech voice hints on what the person said, AR videos showing facets of their lives using Aurasma, a hint page on famous students and a Junaio channel that provides the correct answers.
- A QR wall poster is put out to compose the logo of the Faculty from QR codes leading to interesting web pages illustrating activities at our Faculty.
- ELTE University's Botanical Garden was the scene of the novel “The Boys of Paul Street” by Ferenc Molnár. We set up a channel on Toozla, which contains episodes as auditory narratives situated at GPS position depicted by the novel. Listening to the episodes on spot a questionnaire can be filled out to find out how well one remembers the novel.
- Infographics posters add extra explanatory information with interactives that allow similar polls, viewing the immediate results to facilitate comparison.



Figure 2. A.) Are you smart: <http://bit.ly/VtMNwa> B.) Navigation C.) Students exploring (posters)

4. User experiences

While waiting for an event or person, one often gets engaged in texting, reading emails, listening to music, or looking at posters on the spot (Figure 2. C.). The more one examines an appealing composition, the more the person gets involved and tries to find out what the “message” is. Users at first do not realize that there might be some extras in relation to the exhibited content. They study it as an aesthetic composition by itself. QR codes are recognized first and if the user has never experienced reading one (but seems to know that his/her phone might be able to do so), then it is read and the WOW effect is experienced. If the first QR code reveals relevant information, then the process of discovery begins. QR codes provide only clues (not answers), thus they raise further interest to trigger a deeper quests.

A person posing with a mobile phone with an inquiring face actually attracts others in the vicinity. This is especially true in case of using applications like Aurasma, which does not run on “less smart” mobiles, thus another person is well worth talking to. This is the point where Vygotsky’s “zone of proximal development” (ZPD) starts to play a role [11]. One person is more knowledgeable on the topic than the other and conversation starts by asking about the functionality. If the user has to leave, but did not have enough time to do explorations, then the last thing would be reading the “TakeMe” QR code, to make sure that explorations can be continued at home. Thus the process can go further with deeper discovery learning taking place. Cook phrased it: The nature of learning is being augmented by new digital tools, particularly by mobile devices and the networks and structures to which they connect people. He took forward Vygotsky’s ZPD and named this kind of extension “the Augmented Context for Development” [12].

In September we introduced the IP4ET posters on Researchers Evening, when families with children came to visit our campuses, listened to presentations and explored the area on their own. It was a revealing experience to see how generations co-operated together in finding out the facets of poster content and technology use. Even retired professors visited our campus with their grandchildren to witness the new era of informal scientific explorations that might well lead to their own academic work as an extension or overlay, providing them relevance in using technologies.

5. Conclusions and further work

Some universities have already realized the importance of posters in learning and assessment [13]. Our IP4ET extensions provide enhanced add-on values for research on both the topics and 21st century technological background. The collaborative nature of poster exploration has convinced us that the lack of proper smart phone possession is not an obstacle in the learning process and the diversity of generations within such collaborations could only add value to learning and not take away.

There might well be themes where simplicity requires a minimalistic use of technology that can be enhanced with creativity in artistic directions [14], however our further projects aim to explore the boundaries of using technology for explorations.

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A semiotic-pedagogic framework for the design of a virtual museum of Byzantine art

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Abstract. This paper presents the semiotic-pedagogic framework which assists the design of a virtual museum of Byzantine art. The proposal explains how the framework helps the design process by clarifying issues around the multifaceted problems concerning the knowledge required to use technology for educational purposes and the interpretation of signs and sign processes. The framework takes into consideration the affinity of important principles from cultural semiotics and semiotic aesthetic theories with Vygotsky's "signs" and "tools" and the symbolic function of Byzantine art.

Keywords. Semiotics, Pedagogy, Virtual Museum, Byzantine art, Culture

Introduction

Byzantine art is a form of Christian religious art with a well recognized style that has been formalized during the times of Byzantine Empire. To the present day various kinds of artifacts, such as Byzantine icons, are usually found in physical form in churches, homes and museums. According to the term "icon" an inexhaustible cause of semantic meanings [1] can be said that Byzantine art is a symbolic language of art composed of a system of signs that can be learned. The intention aimed to be fulfilled with this project is to promote the interpretation of the meanings of Byzantine artifacts inside an immersive virtual environment.

The design of the virtual museum is part of an ongoing research study which is done to represent the real museum at the Monastery of Saint John Lampadistis (UNESCO World Heritage Site) [2] and a running project with an aim to create an interactive virtual icon restoration tool that can aid restorers and curators by providing tools for trying various scenarios during virtual restoration [3]. However, the main purpose of the present paper is to propose a combined semiotic-pedagogic framework to guide the design of the virtual museum of Byzantine art. The proposed framework aims to assist the pedagogy and the didactic mediation of this form of cultural heritage holding that the representation of Byzantine art in a virtual environment could be an ideal option-medium for the interpretation of its language by young users.

The framework is twofold. It consists of the “three-dimensional” semiotic model-“Case study Semiosphere” (see Figure 1) that is combined and correlated to the articulated by Mishra and Koehler (also three-dimensional)-Technological Pedagogical Content Knowledge framework (TPACK) [4] (see Figure 2). The Case study semiosphere abstracts the processes related to the generation of meaning from signs (semiotics) and the TPACK the skills (pedagogy) to use technology for educational purposes. By correlating the fields of TPACK with those of Case study Semiosphere; the Content Knowledge (C) to Byzantine culture and art, the Technology Knowledge (T) to Virtual Heritage application and the Pedagogy knowledge (P) to Users-Interpreters we explore the means in which pedagogy informs semiotic theory (and vice versa) in a combined framework.

The overall framework involves the affinity of the symbolic function of Byzantine art with the semiotic approaches from Yuri Lotman-Cultural Semiotics [5] and Charles Morris-Semiotic Aesthetics [6] together with Vygotsky’s foci on “signs” and “tools” within his overall pedagogic theory. The goal is to achieve the interpretation of artifacts in a process of psychological development of young users [7] (Vygotsky’s theory applied for the virtual museum design) by evaluating and transforming children development inside virtual environments by using “signs” (cultural artifacts) and “tools” (virtual tools). The framework is anticipated that can assist further the research for immersive cultural representation in the field of Virtual Heritage [8].

The Case study semiosphere

The concept of the “Semiosphere” is the chief concept of Cultural Semiotics; the field of study specializing on the signs and signs processes of culture. Semiosphere allows the understanding of the interplay between different sign systems and the role of signs in culture in a holistic way considering both part and the whole. The semiosphere was coined by Lotman to be applied in cultural semiotics [5]. In our work, we have devised the “Case study semiosphere” which is a semiotic model consisted from three semiospheres (see Figure 1) containing different kinds of signs interacting with each other. These are: ❶ Byzantine culture and art, ❷ Virtual heritage application and ❸ the Users-Interpreters. Each semiosphere explains the dialogic process where signs of ❶ are communicated with the help of a virtual heritage application ❷ to the Users-Interpreters ❸. A virtual heritage application refers to the use of electronic media in recreating or interpreting cultures as they are today or as have been in the past [8].

The Case study semiosphere is a three-dimensional “borromean knot” [9] which describes the most important principles of cultural semiotics like that cultures have marks (or signs) and that are always sign systems or that cultures have boundaries that abut non-cultural space [5]. The Case study semiosphere owes its inspiration from the “biosemiosphere” bearing Lotman to Peirce’s sign theory and his Categories [9] but furthermore to the ancient theories of Aristotle, Plato and the early Church fathers who studied the phenomenal world experience and the perception of signs [10].

The model together with its cultural significance illustrates the contemporary key idea of Morris that the meaning and valuation in art springs from what Morris distinguished to be syntactics (the relations between the signs), semantics (the relations between the signs and what they designate or denote) and pragmatics (the relation of the signs to their creators and interpreters) [6]. Morris first composed a systematic semiotic aesthetic theory analyzing the semiotic role of the art holding that artifacts

entail the potential to act as sign vehicles in virtue to be interpreted as signs; according to their syntactic, semantic and pragmatic ways of functioning for their observers. In this sense we can use the model to better understand the construct of the aesthetic experience of Byzantine art taking in mind the interaction of the involved sign systems but also integrate it with the TPACK framework.

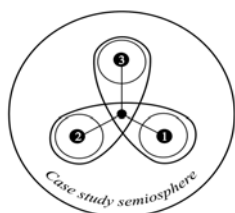


Figure 1. The “Case study semiosphere”

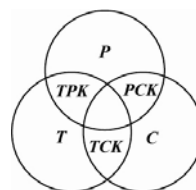


Figure 2. The “TPACK” framework

The Technological Pedagogical Content Knowledge (TPACK)

Similarly to Case study semiosphere, the TPACK (Figure 2) contains three fields but from its own perspective is used to clarify the principles of the complex relationship of integrating education and technology indicating the kind of knowledge required by the teacher who uses technology. Based on the epistemological concept of Pedagogical Content Knowledge (PCK) proposed by Shulman [4]; Mishra and Koehler articulated the notion of TPACK which includes the three knowledge domains; Content (C), Technology (T), and Pedagogy (P), leading to three pairs of integration and one triad.

With the addition of Technology domain (T) were introduced two new pairs and one triad. Besides the Pedagogical Content Knowledge (PCK) the two new pairs are Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK) and the triad: the Technological Pedagogical Content Knowledge (TPACK). The definitions about the three domains of knowledge, the pairs of integration and the triad are quoted as follows from the work of Mishra and Koehler [4]:

- Content Knowledge (C) is the “knowledge of the actual subject matter that is to be learned or taught”.
- Technology Knowledge (T) the “skills required to operate particular technologies”.
- Pedagogical Knowledge (P) is the “deep knowledge about the processes and practices or methods of teaching and learning and how it encompasses, among other things, overall educational purposes, values, and aims”.
- Technological Content Knowledge (TCK) is the “knowledge about the manner in which technology and knowledge are reciprocally related”.
- Technological Pedagogical Knowledge (TPK) the “knowledge of the existence, components, and capabilities of various technologies as they are used in teaching and learning settings, and conversely, knowing how teaching might change as the result of using particular technologies”.
- Pedagogical Content Knowledge (PCK) “includes knowing what teaching approaches fit the content, and likewise, knowing how elements of the content can be arranged for better teaching”.
- Finally TPACK is defined as “an emergent form of knowledge that goes beyond all three components (Content, Technology and Pedagogy)”.

Correlating the TPACK with the Case study semiosphere

The purpose of correlating the TPACK with the Case study semiosphere is to clarify issues around the multifaceted problem about the knowledge required to use technology for educational purposes and the interpretation of signs and sign processes. The affinity between the two models is specifically determined from the correlations between the Content Knowledge (C), the Technology Knowledge (T) and the Pedagogical knowledge (P) respectively to the semiospheres ❶, ❷, and ❸.

Firstly the Content Knowledge (C) is correlated to semiosphere ❶ to stress the fact that the knowledge of this specific subject matter-Byzantine art requires pedagogues who must be equipped with the deep knowledge and understanding for it; secondly the Technology Knowledge (T) is correlated to semiosphere ❷ to show that the knowledge about the technology used (virtual technology) is important for the transmission and the interpretation of Content Knowledge (C); and thirdly the Pedagogy Knowledge (P) is correlated to semiosphere ❸ to emphasize the need for applying pedagogical strategies to help users interpret the symbolic language of Byzantine art.

Based on the approach used in the formulation of the TPACK where the pairs of the triadic integration are analyzed thoroughly, similarly we can analyze the interaction of the Case study semiospheres in their relation with TPACK. The otherwise “fused interaction” of the semiospheres can be explained using the pedagogical principles of TPACK and the pairs of the TPACK can be informed from the semiotic principles of the Case study semiosphere. This is done by focusing on the integration pairs of the TPACK and introducing the semiotic relations with Case study semiosphere.

For instance the Technological Content Knowledge (TCK) is a valuable source of knowledge which informs us how the content changes by the application of technology in a reciprocal relationship between content-technology. Similarly though, we have the relationship sign-technology for which we shall refer to sign (representamen) as something which stands to somebody for something in some respect or capacity [11]. According to the definition of the sign the handling of content with technology shall be studied as handling signs or sign systems (semiospheres) of changing meaning and not only as content (signs) constrained only in certain disciplines.

For example research specific to the correlation between TCK and semiosphere ❶ (Byzantine culture and art) can be directed in testing the implementation of software-hardware (i.e. virtual software, Desktop PC, CAVE, HMD technologies) to handle the semiotic mediation of the content. The flexibility of disseminating the specific subject matter with new ways of representation using virtual technology in accordance to the semiotic changing of the content-meaning is regarded of crucial pedagogic importance. In our case, the development of a virtual museum is carried over the virtual environment platform ScienceSim [12] where we examine its semiotic functionality in respect to the handling of the mediated content and the respective context. Only the use of hypertext is an example of semantic functionality highly regarded as beneficial to the representation of cultural heritage but which much be well thought out.

On the other hand the Technological Pedagogical Knowledge (TPK) including the knowledge about the opportunities of taking into advantage certain technological tools and providing the affordances to accomplish certain educational tasks can be researched inline with semiosphere ❷. In this advance the functionality and efficacy of certain technologies-tools can be researched towards mediating content with pedagogic practices. In semiotic terms this could mean for example the study of the semantic and

symbolic functionality of virtual technology to affect users-interpreters after applying pedagogies explicitly intended for virtual worlds [13].

The third integration, the Pedagogical Content Knowledge (PCK) includes the ways in which content could be transformed for educational purposes excluding the use of technology. Relating PCK to semiosphere ③ the (Users-Interpreters) can be translated for example into research that may involve traditional pedagogic practices; for example the study of collaborative activities analyzing pedagogically the meaning of the Byzantine artifacts (i.e. in religious studies) [14] or the theoretical examination of the problems that concern the development of the virtual icon restoration tool [3].

Designing the virtual museum. A Vygotskian perspective.

Incorporating Vygotsky's ideas to the proposed semiotic-pedagogic framework is important because Vygotsky like Morris and Lotman has a holistic-semiotic view on culture and art but most precisely an educational view of art pertinent with the applied potential of artifacts becoming meaningful and emotional devices [15]. A central aspect of his educational theory is that the use of children's cultural sign systems together with psychological-pedagogical tools (such as language, writing, artworks and technical tools) can transform their development [16]. What's most important from Vygotsky's theory that applies for our case is his approach that children development is socially constructed with the usage of psychological "signs" and "tools" existing in the environment of potential learners, a theory which is inline with the proposed pedagogical framework but also the symbolic function of Byzantine art itself (Byzantine artifacts functionality intends to the development of human culture).

One of the basic premises of an evaluation experiment examining the possibility of the formulation of rules for the communication of Byzantine art to young spectators with multimedia-virtual applications is that users should be scaffolded in their understanding of Byzantine art [17]. The initiated problem for the formulation of guidelines for the specific problem of the communication Byzantine art using new media is seen in the proposed approach that could be traced in its foundation from the distinctions indicated between the semiotic-pedagogic relations.

Further research on this direction involves also Vygotsky's theory on the "zone of proximal development", aspects of the pedagogy of play (edutainment) [7] and the study of applying design techniques for the mediation of cultural content (i.e. Non Photorealistic rendering) [18]. Currently these possibilities are researched within the potential of the proposed framework and the development of the virtual museum on the virtual environment platform Sciencesim [12].

Conclusions

This paper proposes the semiotic-pedagogic framework in a means to guide the design process of the virtual museum of Byzantine art. Inspired from relevant semiotic theories we developed the Case study semiosphere which we correlated to the Technological Pedagogical Content Knowledge framework (TPACK) and examined its affinity with Vygotsky's theory. A design based on the raised semiotic-pedagogic considerations is expected that will make us wiser integratively on a theoretical, methodological and pedagogical level providing many possibilities. Based on the tenets

of the framework we plan to research further the possibilities for evaluation and communication of Byzantine art and culture within the field of virtual heritage.

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