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## **Executive Summary**

This report presents innovative ways of using the immersive technology that fulfils most requirements to provide powerful learning experiences in the field of interview for geographically dispersed learners.

The aim is to select the infrastructure to provide with successful cases of developing interview presentation skills via distance learning and the specifications of the 3D virtual world environment, as well as set the requirements for the functionality and features of the popular 3D virtual worlds and its capabilities of integrating additional modules.

Finally, it concludes with the selection of an environment that is selected as suitable for the successful implementation of all project scenarios.

## List of abbreviations

Abbreviation	Definition
3DVW	3D Virtual World
MRM	Mini Region Module
NPC	Non-Player Character

## Table of contents

1. Background	8
2. Using 3DVW for Educational Purposes	9
3. Specifications of the 3DVW	11
3.1. Functional Requirements	11
3.2. Quality Requirements	12
3.3. Technical Requirements	12
4. Available Environments for Development	14
4.1. Commercial Environments for the Development of 3DVW	14
4.1.1. Active Worlds	14
4.1.2. Second Life	15
4.1.3. Unity	15
4.2. Open Source Environments for the Development of 3DVW	16
4.2.1. Open Simulator	16
4.2.2. Open Wonderland	17
5. The Selected Environment for the Development	19
6. The Envisaged VeLoCiTy Functionality	25
6.1. Actors	25
6.2. The VeLoCiTy Entry Point	26
6.3. The VeLoCiTy 3DVW Functionality	26
Bibliography	27

## List of Figures

Figure 1. An example from an Avatar while testing OpenSimulator for VeLoCiTy Project	21
Figure 2. A Building in the OpenSimulator for VeLoCiTy Project	22

## 1. Background

The VeLoCiTy Project is a European Project financed by the European Commission under the Erasmus+ KO2. The goal of the VeLoCiTy project is to help those individuals seeking for a job by showing them the different types and theories of interviews among the European countries, using a 3D Virtual World (3DVW) to achieve this goal.

The goal of the VeLoCiTy project is to facilitate the search for job seekers in another country by making them familiar with the diversity in the theories and practices of the interviews, partially because of the culture and ethnic differences among the European countries. The above goal will be achieved through an innovative 3DVW learning environment that will include scenarios simulating the most representative interview processes. The 3DVW that will be developed should be able to fulfil a number of requirements to serve this purpose.

This report presents the infrastructures and the immersive technology that fulfils most requirements to provide the 3DVW environment with the functionality and features required for the project needs.

## 2. Using 3DVW for Educational Purposes

A virtual world is “a synchronous, persistent network of people, represented as avatars, facilitated by networked computers” (Bell, 2008). Using a 3DVW for educational purposes fits into the experiential learning principles that support pedagogies such as “learning by doing”, which engage learners in critical thinking, problem solving and decision making, while Communal Constructivism as a potentially appropriate pedagogy for use in the 3DVW (Girvan & Savage, 2010). Virtual worlds are a valuable tool in modern education practices as well as providing socialisation, entertainment and a laboratory for collaborative work (Duncan, Miller, & Jiang, 2012). Therefore, the concept of using a 3DVW to educate learners about the principles of interviews provides a novel concept that will motivate learners. Having in mind that, as well as the fact that ICT technologies are important driving factor for the developments in education, this work aims additionally to empower the profile of the teaching professions in order to adopt novel approaches in teaching.

Many teachers find the idea of adding scenario-based learning to their teaching methods interesting, as it makes classroom experiences more appealing and highly engaging. Generally, scenario-based learning immerses the learners in real life or situational simulations or learning experiences that allow them to gather skills or information that they will recall for future use. The emergence of ICT, has added another aspect that influences to a significant extent the way both educators (experts in the interviews) and participants view the learning process.

As the use of virtual worlds is becoming more popular, more and more learners get acquainted with virtual world environments and new rules for social interaction emerge (Petrahou, 2010). Virtual worlds have been used with success in education, for example Second Life in psychology (Baker, Wentz, & Woods, 2009), in medical and health education (Boulos, Hetherington, & Wheeler, 2007) and in computer

science (Berns, Gonzalez-Pardo, & Camacho, 2013), but to the best of our knowledge this is the first time that a 3DVW is going to be used for the specific purpose of this project which is the concept of interviews.

Our work in the VeLoCiTy project will consider recent reports on the usage of immersive virtual reality technology in education (Ott & Freina, 2015), user behaviours and motivations while they interact with other participants in virtual worlds (Lin & Wang, 2014), as well as how users represent ethnical diversities into virtual worlds (Lee, 2014) and differences in adult's behaviour into virtual worlds (Burnett & Merchant, 2014).

### **3. Specifications of the 3DVW**

The environment that will be used for the development of the 3DVW should be able to support scenarios simulating the most representative interview processes. The main target group is the individuals/interviewees that will benefit directly through the participation in the learning environment, overcoming potential problems such as distance and the space and/ or tutor availability.

Towards this goal the functional and quality requirements related to the interview process simulation and the general selection criteria related to the technical capabilities of the environment, to support the development of the 3DVW were defined.

#### **3.1. Functional Requirements**

The functional requirements of the environment are:

1. To support avatar registration through a custom web interface and avatar customisation inside the 3DVW, so to be able to support different dressing styles suitable for various interview cases.
2. To offer a tutorial area that will be used to introduce participants to the basic controls of both the system and scenarios.
3. To support the creation of various scenarios that can be executed individually, or in groups and to support participants movement instantly to the areas of each scenario.
4. To offer communication mechanisms inside the 3DVW, supporting written text to facilitate dialogues in interviews between participants.
5. To offer voice communication between participants, if needed during any interview simulation of any scenario.

6. To offer basic avatar gestures that could be utilized during any interview simulation of any scenario.
7. To be able to support various languages, if needed translating into partners languages.
8. To allow creation of short scenarios that will take up no more than 30 minutes to be accomplished, so to keep participants motivated.
9. To be able to support the inclusion of related educational information that will be presented as part of each scenario where needed.
10. To be able to support creation of various scenarios in dedicated virtual areas of the 3DVW.
11. To support of both single-user and multiuser scenarios related to the interview simulations that will be selected.

### **3.2. Quality Requirements**

The quality requirements of the environment are:

1. To be friendly and attractive to the participants allowing them to benefit increased interactivity and feedback during the scenarios.
2. To be able to allow participants to feel immersed into the environment and feel as like in a real world as possible.
3. To be enjoyable and maintain a playful character among the participants.

### **3.3. Technical Requirements**

The technical requirements of the environment are:

1. To be cost-free and open-source, as stated in the project proposal.

2. To be able to allow the development of fully customisable and multiuser virtual worlds to simulate various scenarios.
3. To support straightforward server configuration and parameterisation to fully control the 3DVW and the usage rights at will.
4. To allow self-hosting in partners servers.
5. To be able to support multi-platform client software allowing for non-Windows users' participation.
6. To offer 3D graphics and human-like fully customisable avatars to support the issues of immersion and presence.
7. To offer a built-in 3D editor for the creation and editing of 3D virtual objects and landscapes that will be used in the scenarios.
8. To offer good real-time communication through text chat, instant messages and voice.
9. To offer a scripting language to support the implementation of the interview scenarios.

## 4. Available Environments for Development

The 3DVW environments that could be used for the development of the scenarios for the VeLoCiTy Project are an innovative technology that can provide the tools for the creation of highly immersive 3D graphical and interactive online environments.

Such environments can be either replicas of existing physical places, or imaginary places, or even places that are impossible to visit in real life due to restrictions such as cost or safety. These 3DVW environments can be either commercial (therefore a fee is expected for the development of scenarios with them) or open-source.

In the following sections, the most popular in the educational community commercial and open-source 3DVW environments that are currently used for the development of virtual worlds are presented.

### 4.1. Commercial Environments for the Development of 3DVW

Some of the most commonly used commercial 3DVW environments are Active Worlds, Second Life and Unity.

#### 4.1.1. Active Worlds

Active Worlds<sup>1</sup> features a detailed 3D graphical environment and customizable avatars, built-in voice and standard text communication tools (i.e. chat, IM). Although restricted usage is free through an account (called "tourist"), paying a monthly fee allows one to become a "citizen". Only "citizens" can have unique name, unrestricted access to any part of any world on the platform, avatar customization, object building

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<sup>1</sup> <https://www.activeworlds.com/web/index.php>

and access to social networking features such as voice chat, IM and file sharing. For users who need more control over their environment and more privacy, private firewall-protected “Universes” are available for enterprise and educational projects. These are separate worlds from the main universe and their cost varies.

#### **4.1.2. Second Life**

Second Life<sup>2</sup> is the most popular of the Social Worlds, with the largest active user and educational community. It features a detailed 3D graphical environment and customizable avatars, built-in voice and standard text communication tools (i.e. chat, IM). Second Life provides a social network with groups, through which information and object sharing can take place. It also has an in-world economy and an enormous market with user-generated virtual goods and tools. Registration and basic usage is free but the users have the option of paying a monthly fee in exchange for a small parcel of land where they can build a home and become ‘residents’. However, serious building projects require the purchase of a private island or a large piece of land (parcel) in the Mainland. A parcel in the Mainland may be made private and accessible only to those who belong to a group, but visitor avatars may still access the neighboring land. Hundreds of learning organizations -from nearly every country- are either augmenting their current curriculum with a virtual learning component or they are holding classes and entire programs exclusively in immersive learning environments in Second Life.

#### **4.1.3. Unity**

Unity<sup>3</sup> is a 3D professional game development tool which can be used to create from scratch suitable training simulations and educational virtual worlds in 3D which can

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<sup>2</sup> <http://secondlife.com>

<sup>3</sup> <https://unity3d.com/unity>

then be accessed through a client or a web based player. The Unity offers the possibility to develop a set of scenarios and their user interface without having to program in complex computer languages. The language behind the Unity scenes is C#. The development of single-user applications requires only to download and install Unity but the features and properties of the developed training environment depend mostly on the ability to use the content creation tools. The Unity Asset Store, a global marketplace of objects (as well as code) for Unity, provides content (character models, materials and textures, landscape painting tools, game creating tools, audio effects, music, visual programming solutions, scripts, etc) for low cost. Unity evolves with the latest mobile (iOS, Android), desktop (PC, Mac, Linux), Web (web player, Flash) and console (Wii U, PS3, Xbox 360) technology, offering smooth development and deployment of a game with high quality of graphics and solid performance on any device.

## **4.2. Open Source Environments for the Development of 3DVW**

Some of the most commonly used commercial 3DVW environments are OpenSimulator and OpenWonderland.

### **4.2.1. Open Simulator**

OpenSimulator<sup>4</sup> is a free, open-source, 3D application server that allows the creation of 3DVW, where multiple users can simultaneously be present. These virtual worlds can be accessed through various open source clients and can remain private, behind the firewalls, or become public. OpenSimulator is written in C# and its framework is designed to be easily extensible through external modules. OpenSimulator's current architecture is heavily influenced by that of Second Life, allowing the user to produce

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<sup>4</sup> [http://opensimulator.org/wiki/Main\\_Page](http://opensimulator.org/wiki/Main_Page)

from scratch similar highly detailed 3D graphical environments at low cost, or at no cost provided that the hardware/software and the building/scripting/technical skills are offered for free. The avatars are fully customizable and resemble those of Second Life. The in-world communication is based on text communication tools (i.e. chat, IM) and supports voice plug ins as well. The aforementioned reasons plus the freedom of owning, building and configuring the virtual world, have made Opensimulator very popular among the educational and science community.

#### **4.2.2. Open Wonderland**

OpenWonderland<sup>5</sup> is open source based on Java™ toolkit for creating 3D collaborative virtual worlds from scratch. OpenWonderland toolkit allows the creation of modules which can extend any part of the system (client or server) and add functionality. Out of the box and with a bit of software development effort, customized, special-purpose virtual worlds can be created. Some examples of the external modules that have been created by different developers and can be downloaded from the Module Warehouse are: Authentication system, webcam viewer, writable (text or HTML) poster, collaborative text editor, etc. Open Wonderland offers the ability to run Java applications inside the virtual world. A distinct feature of Open Wonderland is the ability to easily bring in existing content. The list of document types that can be dragged and dropped into the world is ever growing. Moreover, a creator can import any content found in the Google 3D Warehouse. Open Wonderland does not offer in-world 3D building, but 3D items can be imported from Maya, Google SketchUp, Blender, etc. Also, OpenWonderland does not support avatar's inventory. Within its worlds, users can communicate with high-fidelity, immersive audio, share live desktop applications and collaborate in an education or business context (simulations, meeting rooms, mixed-reality worlds, etc).

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<sup>5</sup> <http://www.openwonderland.org>



## 5. The Selected Environment for the Development

Based on project requirements and having open access as a priority, as well as sustainability, the commercial environments could not be selected. From the open environment, The VeLoCiTy consortium selected the OpenSimulator environment to be used for the development of the scenarios for this project because it fulfills all the requirements described in Section 3 set by the consortium of VeLoCiTy. Additionally, its compatibility to Second Life, the most popular 3D virtual world platform for educators all over the world, as well as its open and modular design, makes it ideal for educational institutions that need to have full control and maximum flexibility on their 3D simulations.

The virtual worlds of OpenSimulator offer pretty much the same graphics, functionality and building possibilities as Second Life but without incurring licensing costs. Furthermore, anyone who wishes to develop virtual worlds on OpenSimulator platform could benefit from the intellectual outcomes of the two very large and active educators' and developers' communities, which is a major advantage for someone who is not experienced in this field.

The OpenSimulator 3DVW environment facilitates the development of 3D scenarios using a variety of technologies and is easily extendable through loadable modules that enable to build completely custom configurations and embed extra functionality to the platform. OpenSimulator is being developed in C# programming language and it is released under a BSD License, making it both open source and commercially friendly to embed in products. OpenSimulator can be used to simulate a virtual environment similar to Second Life (including client compatibility due to the same client-server communication protocol).

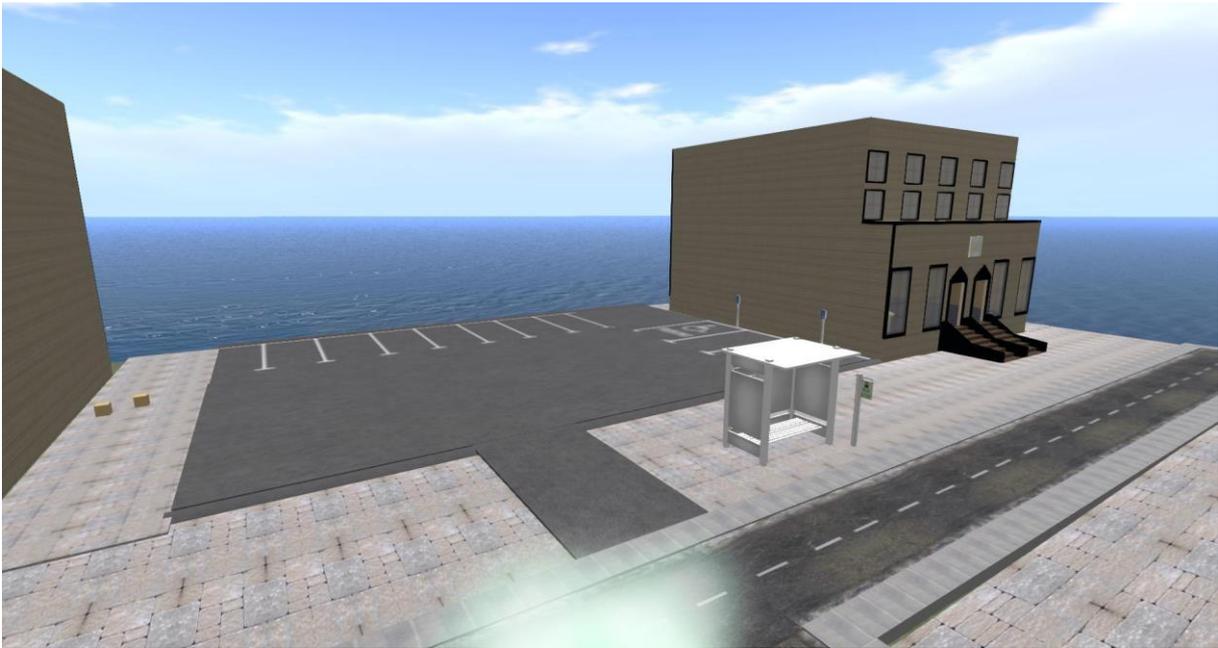
The main advantage of OpenSimulator is the impressive 3D graphics that create an environment that can attract user's attention and facilitate immersion. Built into the software of OpenSimulator is a 3D modeling tool which is based around simple “prims”, allowing the avatars to link them and build complex virtual objects. After creating such objects any texture can be applied to make them look any way one can imagine. Numerous advanced features are provided such as skew, rotation, cuts, shadows, lights and photorealistic aids, which help the creator design an impressive scene.

The client program enables users to interact with each other through Avatars (human shaped computer figures). An example of an Avatar is shown in figure 1. A single user account may have only one avatar at a time, although the appearance of this avatar can change between as many different forms as the user wishes. Avatar forms, like almost everything else, can be created by the user with the use of a high-level interface. The avatar can be dressed up as the user desires, interact with other objects and avatars and even animate some physical movements of a user's choice.



**Figure 1. An example from an Avatar while testing OpenSimulator for VeLoCiTy Project**

Regions in OpenSimulator are the building blocks of the virtual world. Each world hosted on the OpenSimulator environment consists of one or more regions. A region is the virtual physical space where avatars move and interact. It is a square patch of land (256x256m<sup>2</sup>) like an island on which mountains, buildings, etc., can be created. Every region is located at predefined coordinates on a XY axis on a VW map. They can be adjacent, forming greater land masses or apart. Transportation between distant regions can be achieved through teleporting. Users can build various 3D objects in such islands. Figure 2 shows a building created in OpenSimulator for the VeLoCiTy project in the stages of testing OpenSimulator.



**Figure 2. A Building in the OpenSimulator for VeLoCiTy Project**

Users can communicate via local chat or global instant messaging (known as IM). Chatting is used for localized public conversations between two or more avatars, and is visible to any avatar within a given distance. IMs are used for private conversations, either between two avatars, or among the members of a group, or even between objects and avatars. Unlike chatting, IM communication does not depend on the participants being within a certain distance of each other. Instant messages may optionally be sent to a user's email when the user is logged off, although message length is limited. If a message is sent to an offline user it will also be saved to be viewed when the user logs on again.

When considering the OpenSimulator environment, VoIP functionality is not a built-in feature but there are several external modules that can enable users to have voice chat in-world. However not all of them are able to offer realistic voice representation (i.e. lip sync, 3D sound etc) and they require some extra system configuration.

An important feature of OpenSimulator is the scripting which lies at the core of the platform's engine. OpenSimulator script engine XEngine is responsible for the compilation of the scripts to ".NETassembly" before execution. Second Life supports LSL (Linden Scripting Language) which has certain limitations in terms of programming structures and speed of execution. OpenSimulator currently supports LSL, OpenSim Scripting Language (OSSL) and C# scripts. These scripts can be written in-world and are embedded in the virtual objects, making them "alive", offering them capabilities like movement, communication, reaction to avatars' or other objects' actions, shape changing, etc.

If the developer needs more functionality than simple LSL or OSSL can offer, more complex forms of scripting, such as Mini Region Module (MRM) scripting, are available. Mini Region Module is written in C# (like OpenSim itself), but unlike the currently implemented C# engine, contains a vastly different object-oriented API.

Non-Player Characters (NPCs) are programs that can be used to control in-world avatar in an automated way. NPCs are perceived as virtual clients so they do not overload the server as if they were real users' clients. For this reason, they can be as many as the simulation/game designer needs. Such functionality can prove extremely helpful when trying to implement scenarios where the users must interact with NPCs. NPCs can also be programmed to perform in-world maintenance or administration tasks. The OpenSimulator environment offers numerous NPC-dedicated OSSL functions that can be applied to create scripts that control a Bot as desired.

OpenSimulator can operate in two different modes: a) Standalone or b) Grid mode. In the standalone mode, a single computer process (OpenSim.exe) handles the entire simulation and the services of the virtual world. Standalone mode is simpler to

configure, but is recommended for “light” worlds and smaller number of concurrent avatars. In grid mode, the services are not part of the 3DVW simulation process. Instead, they run in a separate process (Robust.exe). A Robust shell can run all the services or they can be split amongst any number of Robust instances. This allows them to be run on entirely separate machines if necessary. In this mode, the OpenSim.exe acts solely as the 3DVW simulator, serving one or more regions that communicate with the separate services. This mode is recommended for “heavy worlds” (hosting more than 3 regions) and many concurrent avatars because it improves scalability, since the aforementioned processes can work on different physical machines, and thus utilize more resources.

## 6. The Envisaged VeLoCiTy Functionality

The functionality of the project is defined by identifying a) the 'actors', who are the persons who interact and have a specific role in the 3DVW b) the entry point of the 3DVW, which is the 3DVW initial registration and authentication interface and c) the features and characteristics of the 3DVW that will be offered to all types of actors while exploring and interacting with the scenarios of the 3DVW.

### 6.1. Actors

The 3DVW of VeLoCiTy includes 5 distinct categories of actors:

1. Educators, which are participants experienced in the field of the interviews that enter the 3DVW with the purpose to transfer knowledge by their participation in specific scenarios that require the presence of an educator.
2. Learners, which are unemployed or students that enter the 3DVW to participate in one or more scenarios to gain knowledge about interviews.
3. NPCs, which are programmed to be part of some scenarios to facilitate the scenario plot.
4. Content Managers, which are the person(s) responsible for the management of the educational content presented in the 3DVW. They are also responsible for the management of the user accounts. Typically, they can also be some of the educators.
5. 3DVW administrators, which are the person(s) responsible for the 3DVW maintenance, development and technical support. They are also responsible for the management of the users' accounts in OpenSimulator environment.

## **6.2. The VeLoCiTy Entry Point**

The project web site will be used as the web portal to the 3DVW and will offer the basic information about the project scenarios. It will offer links to download the viewers, link to download the user handbook, basic information for each scenario, news for multiuser scenario participants synchronization.

## **6.3. The VeLoCiTy 3DVW Functionality**

The 3D Editor of Opensimulator will be used to create and modify the virtual settings, i.e. the buildings, the objects, the landscapes, based on the scenarios that will be developed for the VeLoCiTy project. The LSL/OSSL scripting languages will be used to create the scripts that will add interactivity to the virtual objects.

The 3DVW of VeLoCiTy will offer: An Introductory Area, that is the initial area when logging in the 3DVW which will introduce the players to the basic controls of the viewer. Furthermore, probably in a single building the 3DVW will include: An Educational Area, which will offer educational material related to interviews; A Leisure Meeting Area for socializing purposes or briefing discussion between educators and learners; A Teleporting Area where scripted 'digital gates' (aka 'Teleporters') will transport the participants to the virtual area of the selected scenario.

Finally, each one of the VeLoCiTy scenarios will be simulated in a dedicated 3D virtual setting. Each scenario area will host the interactive 3D objects, NPCs and all scenario related mechanics that are required to support the flow of the scenarios. For each scenario, the Avatar Inventory will include the proper items required for this scenario (various clothing, inventory items such as briefcase or notes, inventory cards with important scenario related information, etc.).

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