New Directions in Science Communication: A Virtual Research & Experience Landscape

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Abstract: In this paper we present the virtual learning environment "Research Exhibition and Experience Landscape – REEL", which is a platform for communicating scientific projects. REEL allows users to observe and participate in scientific research. We created hands-on experiences in the Virtual World of Second Life, which allow the student to directly step in the field of research and learn in a playful way. REEL showcases the results of the e-Tourism project "Itchy Feet", which provides a 3D e-Tourism environment for providers and consumers that enables versatile interaction between participants including trading of tourism products. REEL explains complex matters in a graspable and understandable way.

Introduction

The possibilities of transferring knowledge, especially in the field of e-Learning, have changed noticeably since Information and Communication Technology (ICT) is being used in schools and universities. The first offline learning programs were released in the beginning of the 90's. They were simple and provided limited interaction with the software. With the success of the Internet, Web Based Training applications attracted more and more attention. For the first time teachers had the possibility to exchange educational material directly online and to benefit from the advantages of communication via the Internet. The next step was the combination of face-to-face education and e-Learning methods, so called *Blended Learning* (Dodero et al. 2003). The main objective of Blended Learning is to change the role of the learner from a passive listener and directly involve her into an active learning process. The student creates and controls her own learning environment. In addition, Web 2.0 provides new ways for transferring knowledge. Blogs, Wikis and Online Social Communities allow the user to customize the learning environments to enhance learning experience (Huang et al. 2008).

Teaching in Virtual Worlds recently became more popular. These Virtual Worlds can be used as a basis for new learning scenarios, where avatars explore and create content on their own. Virtual Learning Environments (VLEs) are often static and do not provide tools to interact with the surroundings. Especially when it comes to convey very complex knowledge, Virtual Worlds offer new possibilities for schools and universities to make use of a collective learning experience. Science communication is about communicating complex scientific knowledge and may benefit from new technologies. Virtual Worlds make it possible to observe the users, represented as avatars, while exploring the learning environment. They can immediately influence processes and control knowledge transfer. De Freitas (2008) mentions that Virtual Worlds provide excellent capabilities for creating effective distance and online learning opportunities by providing unique support for distributed groups. They can bring together experts and tutors from around the world and open new opportunities for learning in international and geographically independent groups. Actually some well-known universities, such as the Harvard Law School, are teaching in Second Life.

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We have developed the Research Exhibition and Experience Landscape REEL. It is based on a Virtual World that aims at science communication. REEL allows every user to take part in scientific research by posting ideas and comments.

The remainder of this paper is organized as follows. In the next section we provide a discussion of related work in the fields of knowledge transfer, science communication and learning in virtual worlds. Then we outline the underlying concept of REEL and the thematic showcase "Itchy Feet", a 3D e-Tourism environment. The next chapter describes the implementation and design of REEL by taking a virtual walk through the environment. Finally we conclude with directions for future work.

Related Work

Knowledge transfer, either in companies, educational facilities or Virtual Worlds, is a complex subject and basis for many research projects. It becomes even more difficult when members of virtual teams are geographically separated and share different cultures. Newell et al. (2006) outline the characteristics of knowledge that make its transfer problematic and describe it as distributed, ambiguous and disruptive. It is important to create a common understanding and a mutual base to enable knowledge transfer. Sarker et al. (2003) identify four factors, "The 4 C's", that enable knowledge transfer among virtual teams. The first is the capability difference, which allows a person with a greater reservoir of knowledge to transfer more knowledge to the recipient than a source with a limited knowledge base. The second "C" claims that individuals who have a high level of credibility will transfer more knowledge to others members. The third "C" aims at the importance of communication in virtual teams, facilitating the sharing of individual ideas, new viewpoints and beliefs. The last "C" describes cultural differences. Virtual team members from less individualistic societies will transfer more knowledge to their remote team members. These four factors, which are mainly targeted at knowledge transfer in companies and businesses, can also be considered for educational purposes.

Apart from all diverse use cases of Virtual Worlds, they may be used for education or to present scientific work. In many cases existing 3D game engines are adapted for "serious" purposes. The term "Serious Gaming" refers to computer games used for non entertainment purposes including educational technology, scientific exploration, health care, emergency management or military training (Conconi et al. 2008). Especially the transfer of complex scientific knowledge is hard to accomplish. For example, the department of physics at the University of Vienna published a DVD documentation, which shows the work of scientists in the field of quantum physics. A camera crew accompanied the scientists, while they were arranging different experiments. The scientists and the movie makers communicate how the daily routine of a scientist looks like, how experiments are conducted and which successes or failures can emerge. The documentation was made for more senior pupils from secondary schools in order to awaken their interest in the work of a scientist. This is a quite conventional way to communicate scientific knowledge. In this case the student acts as receiver, who is not interactively integrated in the process of learning. In another approach, which demonstrates the work of architecture students at Vienna University of Technology, the learner becomes an active part of science communication. The VIPA project (VIrtual campus for virtual space design provided for European Architects) provides a virtual research platform and a virtual campus (Hoog et al., 2007). By integrating the learning management tool Moodle into the Virtual World of Second Life, a collaborative and immersive lab for students was created. In the initial phase, Second Life was used as a meeting place and as a presentation platform for the results of the students' work. The in-world build tool of Second Life makes it possible to work on objects in real-time within the game, offering a collaborative design process. In the context of *archdiploma2007* [1], a biennial exhibition of the best architecture diplomas at the Vienna University of Technology, the projects were recreated as 3D virtual objects. The visitor had the chance to walk through the buildings and experience the design process in an immersive open-air museum, giving a much better impression of the concept than a picture. By means of presenting architecture in a playful way, it gets more graspable for those, who are not directly involved in this field. The main goal was to communicate science by creating a hands-on experience for the visitor.

Another approach focuses on the automatic arrangement of scientific multimedia items in a Virtual World. "The Media Square" allows users to explore multimedia information, which is structured and organized within space. The player, impersonated as an avatar, experiences multimedia content by literally walking through it (Genswaider et al. 2008). "The Media Square" comprises a music showroom, a video and image showroom and 3D scientific library. The content is represented as 3D objects and structured automatically in the Virtual World, based

[1] http://slurl.com/secondlife/arch%20tuwien/128/128/22

on different feature extraction algorithms. Audio features, for instance, are the rhythmical structure and loudness sensation. This work led to the development of "Beyond: The virtual MUSCLE Experience", which is the continuation of "The Media Square" and provides an immersive information center for the MUSCLE network [2], ensuring continued sustainability of the achievements. "Beyond" is an environment for science communication, teaching the underlying scientific technological building blocks as well as introducing members and institutes. A web-based administration interface allows the user to enter information about a project or an institute. This information is then visualized automatically in the Virtual World of Second Life. The content of every project is represented by a container object which holds several screens showing related information. These containers are connected by gateways and teleporters. Institutes or showcases, which have strong relation, are automatically arranged by an unsupervised clustering algorithm. In addition, "Beyond" [3] provides a welcome area, a showcase area, a video area and a hands-on area for interactively presenting projects.

The Virtual World of "River City" provides an educational environment that is aimed at secondary school science classrooms. As a visitor of "River City", students travel back in time, bringing their 21th century skills and technology to address 19th century problems. The virtual town of River City is besieged with health problems and students work together in teams to find out, why residents are becoming ill. Students learn how to behave as scientists while they collaboratively identify problems through observation and inference (Dede et al. 2004). These educational learning environments can help to stimulate the interest of students. The "Mixed Reality Teaching and Learning Environment" (MiRTLE) also benefits from the usage of virtual 3D environments in education. This project combines local and remote learners in a traditional university lecture-based setting (De Freitas 2008). The students attending the lecture remotely are displayed as avatars in the virtual world on screen at the front of the real world classroom, which is equipped with microphones and a camera. In this way, remote learners are part of the lecture and can communicate via text and audio links with the physically located class members. The 3D environment is based on *Project Wonderland* [4], an open source toolkit for creating collaborative Virtual Worlds. The main strengths are its focus upon collaboration and information representation using audio, video streaming and application sharing. MiRTLE can be used for lecture-based activities providing a means of bringing together learners from different geographic area either purely in-world or in a mixed-reality setting.

Sloodle (Second Life Object Oriented Dynamic Learning Environment) integrates the free and open source e-Learning platform Moodle into Second Life. Moodle is a course and learning management system, designed to help educators create online courses with opportunities for rich interaction. The main goal of Sloodle is to mimic the structure of a Moodle course homepage with 3D objects by linking 2D and 3D space (Livingstone et al. 2004). The standard Second Life user interface was enhanced with head-up displays and toolbars for blogging and performing typical classroom gestures like raising a hand. A key challenge, which remains for future developments, is creating innovative and useful metaphors and concepts for displaying 2D web-based content in a Virtual World.

Research Exhibition and Experience Landscape

The goal of science communication is to pass on complex content. By means of science communication, education facilities make their field of research accessible to those, who are not directly involved in and familiar with the work of scientists. The Information for researchers is presented low-leveled and detailed, whereas information for others is abstract and illustrated with examples. The presentation of knowledge is a matter of the target group. Science communication is about opening a new channel that transfers knowledge on a different level. For this purpose knowledge is abstracted and presented in a hands-on manner to the learners. In practice, science communication in Virtual Worlds often makes use of hands-on experiences, which allow the user to directly step in the field of research.

The concept of the Research Exhibition and Experience Landscape (REEL) combines the presentation of knowledge with the unique possibility for the target group to take part in scientific research. Users can actively witness the progress of a project in a Virtual World. The visitor of REEL is to a certain extent involved in the scientific work. The collective experience and the possibility to cooperate are the main characteristics of social software platforms and Web 2.0 applications. For REEL we considered three objectives. First of all information is presented in an understandable and appealing way which goes beyond written text. For this purpose REEL includes hands-on areas that allow the visitor to directly interact with research. We will visualize the research field with 3D

[2] http://www.muscle-noe.org/
[3] http://ispaces.ec3.at/muscle_secondlife.php
[4] https://lg3d-wonderland.dev.java.net/

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objects, inviting the user to walk through it. Secondly everyone can leave messages at the exhibit and post ideas or comments. The visitor becomes an active part in scientific research. In addition, the people and institutions involved in the project are introduced by different media such as text and short video clips. By means of combining media we address additional sensory channels, which facilitate the process of learning.

In the light of the above REEL is designed as a virtual venue, exhibiting scientific projects. We have decided to realize REEL in the Virtual World of Second Life [5]. Users have the possibility to visit the area, interact with other people, learn about projects and become an active member of a community of tutors and students. Users just have to download the client software and choose a name for the avatar.

Second Life was launched in 2003 and experienced a dramatic increase in the number of users since then. On average 40.000 people are logged in at any time (as of March 2009). De Freitas (2008) argues that virtual worlds provide excellent capabilities for creating effective distance online learning opportunities by providing unique support for distributed groups, such as online chat, the use of avatars or document sharing. Second Life provides possibilities for learners and tutors to collaborate in an immersive 3D environment. A study among 107 college students showed that, in direct comparison to Web 2.0 applications like Blogs and Wikis, many learners have a high anxiety level in participating in social virtual environments, because they were not familiar with the navigation in Virtual Worlds (Huang et al. 2008). This makes it important to provide some guidance to users, in order to avoid them to "get lost" in the Virtual World. Second Life offers many ways to address this issue. Avatars can be lead through the area by voice chat, explaining the most important places and functions of the virtual world. Another approach is the use of signs and guideposts to show the user the right way. All these matters are closely connected with the field of Game Design and Serious Gaming, which significantly influenced the design of REEL.

For REEL a private island within Second Life was rented. It provides 65.536 square meters of virtual space. Content is created with Second Life's in-world modeling tool. The landscape is divided into five areas, separated by sea (see left picture in Fig. 2). All are about the same size and each addresses a different objective of the showcase. The five areas are: Welcome Area, Demonstration Area, Learning Area, Project Area and Team Area. The navigation on REEL Island makes it possible to *teleport* from every area to another, to facilitate the exploration of the whole area. Every member of the project team is dressed in a special REEL shirt and immediately noticeable as contact person for questions and suggestions. Second Life allows every avatar to join groups. The group "FWF REEL Project", specifically established for this project, informs all the members about upcoming events and innovations.

The "Itchy Feet" Showcase

The Virtual World showcases the research project "A3D e-Tourism Environment" *Itchy Feet*. Tourism has illustrated how the Internet can change the structure of an entire industry and, in the process, create new business opportunities. The development of more specialized services and further consumer integration will lead to smart marketplaces integrating all stakeholders. However, current e-Tourism applications are dominated by rather conservative approaches towards user-interface design. Considering the current success of Massively Multi-User Online Role-Playing Games on the one hand, and the growing market share of tourism products being bought online on the other hand, the combination of entertainment and business has the potential of creating enormous synergies for e-Tourism. The principal goal of the Itchy Feet project is to develop an instrument to support the complex interaction patterns of providers and consumers in an e-Tourism setting (Berger et al. 2007). In particular, these providers and consumers, either humans or software agents, are members of a heterogeneous society cohabiting in a multi-agent based 3D virtual environment. This principal goal subsumes three sub-goals. The first one is to provide a 3D e-Tourism environment for providers and consumers that enables versatile interaction between participants including trading of tourism products. Secondly it provides a 3D e-Tourism environment that acts as a community facilitator to create and establish a lively and sustainable community involving both providers and consumers. Furthermore a 3D e-Tourism environment will be created that is information-rich to provide transparent and unified access to disparate multi-media information sources.

In recent years the field of e-Tourism has experienced a significant change. The shift towards Web 2.0 created new types of web services and communities, which influenced the tourism domain. Dippelreiter et al. (2007) evaluated eight tourism communities with respect to Web 2.0. In contrast to long established communities, the recently established ones set a higher value on user generated content, such as travelogues or reviews of hotels and destinations. The Itchy Feet project relocates the providers and consumers in an e-Tourism setting into a Virtual

[5] http://www.secondlife.com

World. The REEL project presents background information on Itchy Feet and allows the visitor to learn more about the field of e-Tourism in a playful way. First prototypes of research work, e.g. a tool to identify the tourist type of the visitor, explain complex matters in a hands-on way and invite the user to explore the 3D environment.

A Walk through the Island

Consider a user searching the Internet for new online communities that deal with the topic of tourism. She comes across the project homepage of Itchy Feet [6] and follows the link to REEL (Fig. 1).

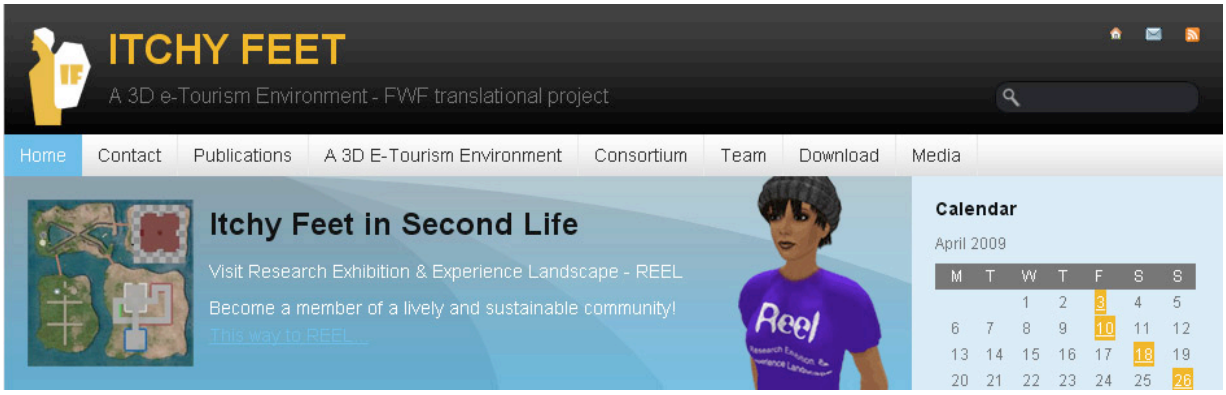

Figure 1: REEL and the Welcome Area

A small map shows the ground view of the island in the browser arousing her interest in visiting the Virtual World. She downloads and installs the free Second Life client. The teleport button on the Itchy Feet website teleports her directly to the Welcome Area (Fig. 2, picture on the right), where she starts by customizing her avatar. As she walks around, different text boards explain the Itchy Feet project and the exhibition to her. To avoid confusion, the Welcome Area is kept simple and does not irritate her with too much information or hard facts. The surrounding is designed naturally, showing trees, lakes, hills and other decorative elements. The openness of the Welcome Area awakens her desire to explore the whole island on her own. To make orientation easier, an initial information-sign lists all the different areas. In addition, the Welcome Area invites her to follow the *Information Path*, explaining the basic concept of e-tourism, virtual environments and describing the other parts of REEL. Links to the external web page and the group "FWF REEL Project" provide additional sources of information such as names of group members and news. The Welcome Area uses short text passages to transfer knowledge to the visitor. This method is an effective way to communicate basic knowledge to the audience, without going too much into detail.

Another approach can be found at the Demonstration Area (Fig. 3, picture on the left). She crosses a small bridge that brings her to a scenic garden, called the Demonstration Area. Here, the prototypically implemented applications of the Itchy Feet project are exhibited and explained in a playful way. Small hedges, trees and walkway separate the prototypes from another, providing an own microcosm for every application. The main objective is to present the functionality of the prototypes in an understandable and tangible way while concealing the complex scientific background in order to keep the exhibit accessible for a large audience. She is able to learn about the research fields, without being bothered with too much knowledge that forms the basis of the application. This information experience communicates knowledge in a playful way.

[6] http://www.itchy-feet.org

Figure 2: REEL and the Welcome Area

Currently, the Demonstration Area displays the "Tourist Profiler", a tool that allows the visitor to identify her respective type. When entering the Demonstration Area, the visitor is asked, if she wants to know her tourist type. Merkl et al. [2008] provide the basis for this prototype and postulate the hypothesis that particular tourism-related photographs can be used to derive a tourist's type. A survey was conducted to capture the tourism preferences of the participants, from Anthropologists, who are mostly interested in meeting the local people and speaking the language, to Thrill Seekers, who are interested in risky, exhilarating activities. In total 17 different tourist types were identified and every type was associated with a set of photographs through a user survey. The significance level of individual photos to distinguish between tourist types was analyzed by means of logistic regression. Those photographs, that characterize a particular tourist type, were used in the final implementation of the photo-based tourist type profiler. In Second Life, the profiler is realized as a tower, consisting of six platforms. Getting back to our avatar, she starts at the entrance of the Demonstration Area and is guided through a short passage, explaining the purpose and functionality of the profiler. She is invited to take a suitcase (Fig. 4, picture on the left), which is used as a device to store the selected photographs. On the first platform she chooses one of the ten photographs, showing specific tourism situations (Fig. 4, picture on the right). Miniatures of the photographs already selected are depicted on a head-up display. She moves on to the next five platforms, choosing photos on every level. Leaving the final platform, a teleporter takes her back to the ground, where a red barrier tape guides her through a scanning device, similar to the ones used at airports. As soon as she moves through the scanning device, the selected pictures are analyzed and the best-matching tourist types are described in a notecard window. To emphasize the playful touch of the tool, she receives gadgets that are related to her tourist type, e.g. a swimsuit, a t-shirt and thongs for the "Sun Lover". The most important goal of the Tourist Profiler is to hide the complex process of analyzing the chosen photos and the extensive survey and research, which was conducted previously. The Tourist Profiler is one deliverable resulting from the Itchy Feet project.

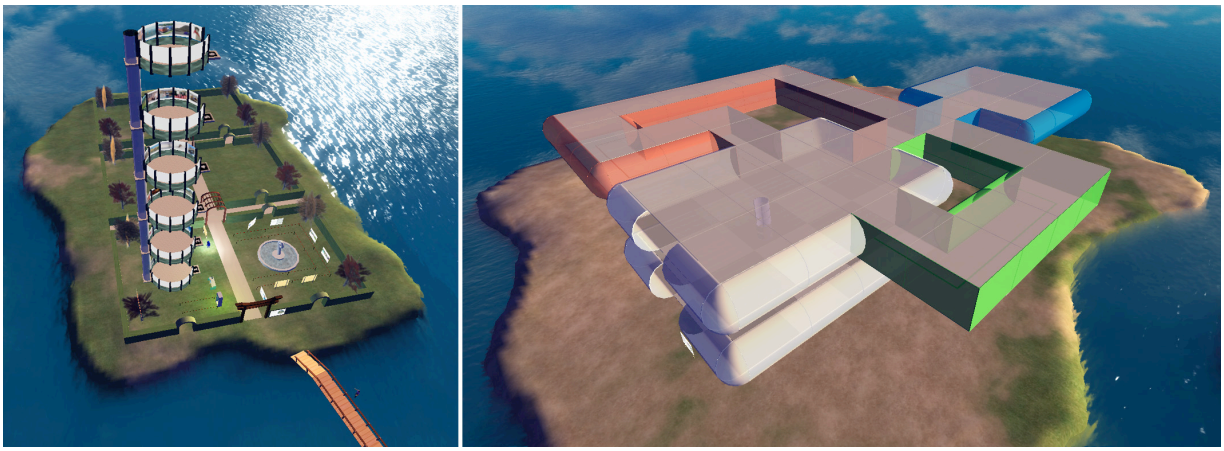

Figure 3: Demonstration Area with Tourist Profiler, Learning Area

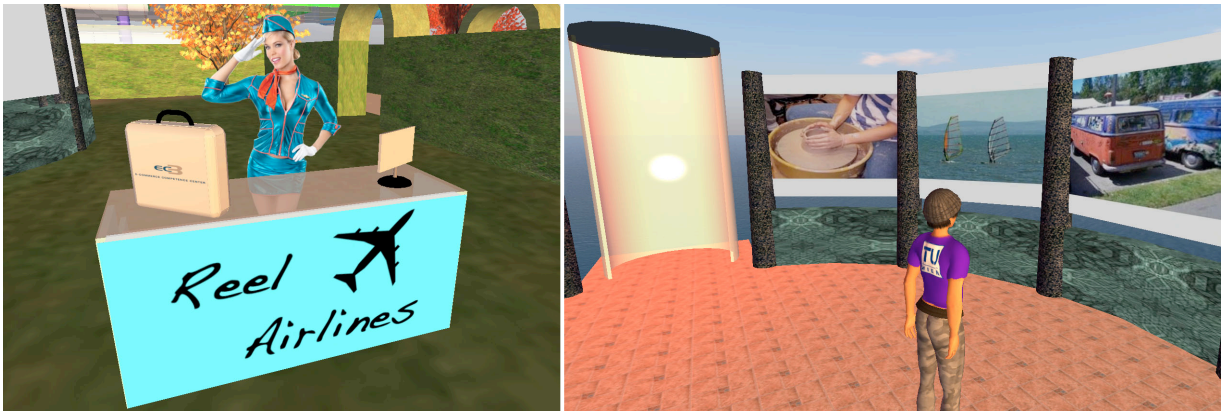

Figure 4: The avatar takes a suitcase and chooses one photo on every platform

To provide the possibility for her to be more closely involved the research project, we integrated feedback mailboxes into the Demonstration Area. She can send suggestions, ideas or points of critique to every exhibit. We implemented a reward system to reimburse her expenses. Users that contribute valuable comments or suggestions get an invitation to a special group. The membership to this group allows the *hobby scientist* to display the virtual degree "Dr.scien.virt.jun." above the avatar's name. This step is an incentive to explore the exhibits.

A wooden bridge leads her to the Learning Area (Fig. 3, right picture). However, this building is not filled with content yet. Here she will find information about the research field and the technologies that are the foundations of the Itchy Feet project. To make this abstract information easily understandable, every piece of content will be visualized by descriptive 3D objects. The method of using 3D objects for transferring abstract knowledge is a way to assist more visual types of learners. The Learning Area resembles a modern museum. The different tube-like corridors vary in terms of color allowing a separation of the content. Lines on the ground lead her through the exhibition. Because of its construction method, the building can be easily adapted to special needs.

She walks on to the Team Area (Fig. 5, picture on the left) that shows all the persons and institutions involved in the project. Every person introduces himself in a short video clip, which can be watched directly in Second Life. The usage of multimedia elements in the virtual world addresses additional sensory channels, fostering the progress of learning. She walks on to the upper floor of the building, where the conference room is located that provides the space for workshops and meetings. The Project Area (Figure 5, picture on the right) is geographically and thematically closely connected to the Team Area. This building will show the work packages of the project, as well as the national and international co-operation partner. The whole structure of the Itchy Feet project will be illustrated by visualizing the work packages in an understandable way. The Project and the Team Area are kept less playful than the other areas. The visitor has to get the impression that the communicated content is more serious than the hands-on experience in the other parts of REEL Island.

After finishing the walk through the island, she joins the group "FWF REEL Project" in Second Life to be kept up-to-date about upcoming events and innovations.

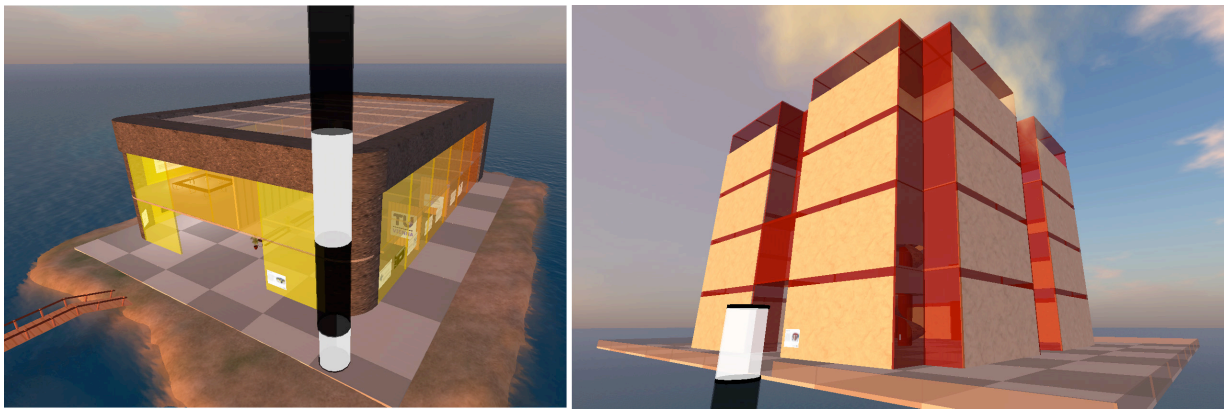

Figure 5: Team Area and Project Area

Conclusion and Future Work

In this paper we have presented the Research Exhibition and Experience Landscape (REEL). It's objective is to offer an innovative approach to communicate information about scientific progress in the Virtual World of Second Life. REEL provides hands-on tutorials to visitors that help to learn about complex scientific matters in a playful way. REEL showcases the 3D e-Tourism environment Itchy Feet and presents a picture-based tourist type profiler. Future work will include populating the Demonstration Area with interesting and informative prototypes, finalize the construction of the Learning Area and illustrate the status of the project in the Project Area.

References

Berger, H., Dittenbach, M., Merkl, D., Bogdanovych, A., Simoff, S., and Sierra, C. (2007). Opening new dimensions for e-tourism. *Virtual Reality*, 11(2). 75–87.

Conconi, A., Ganchev, T., Kocsis, O., Papadopoulos, G., Fernández-Aranda, F., and Jiménez-Murcia, S. (2008). Playmancer: a serious gaming 3d environment. In *Proceedings of the International Conference on Automated Solutions for Cross Media Content and Multi-channel Distribution (AXMEDIS '08)*, pages 111 – 117. Washington, DC, USA: IEEE Computer Society.

De Freitas, S. (2008). Serious virtual worlds: A scoping study. Retrieved April 14, 2009, from: http://www.jisc.ac.uk/media/documents/publications/seriousvirtualworldsv1.pdf

Dede, C., Nelson, B., Ketelhut, D. J., Clarke, J., and Bowman, C. (2004). Design-based research strategies for studying situated learning in a multi-user virtual environment. In *Proceedings of the 6th International Conference on Learning Sciences (ICLS '04)*, pages 158-165. Santa Monica, CA, USA: International Society of the Learning Sciences.

Dippelreiter, B., Grün, C., Pöttler, M., Seidel, I., Berger, H., Dittenbach, M., and Pesenhofer, A. (2008). Online tourism communities on the path to web 2.0 - an evaluation. *Information Technology & Tourism* (accepted for publication).

Dodero, J., Fernández, C., Sanz, D. (2003). An experience on students' participation in blended vs. online styles of learning. *ACM SIGCSE Bulleti*, 35(4). 39-42.

Genswaider, R., Berger, H., Dittenbach, M., Pesenhofer, A., Merkl, D., Rauber, A., and Lidy, T. (2008). A synthetic 3d multimedia environment. In *Computational Intelligence in Multimedia Processing: Recent Advances*, pages 79–98, Berlin/Heidelberg, Germany: Springer.

Hoog, J., Falkner, C., and Seifried, P. (2007). Collaborative spaces as learning environments. In *Proceedings of the 3rd International ASCAAD Conference on Em'body'ing Virtual Architecture*, pages 357 - 364. Alexandria, Egypt: Society for Computer Aided Architectural Design.

Huang, W. D., Yoo, S. J., and Choi, J.-H. (2008). Correlating college students' learning styles and how they use web 2.0 applications for learning. In *Proceedings of the World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education (ELEARN '08)*, pages 2752–2759. Chesapeake, VA, Canada: AACE.

Livingstone, D., and Kemp, J. (2008). Integrating web-based and 3d learning environments: second life meets moodle. *UPGRADE European Journal for the Informatics Professional,* 9(3). 8–14.

Merkl, D., Berger, H., Dittenbach, M., and Pesenhofer, A. (2008). Tourist type profiling in web 3d: a second life experience. In *Proceedings of the IADIS International Conference on Information Systems*, pages 29 – 36. Algarve, Portugal: IADIS Press.

Newell, S., and Galliers, R. (2006). Knowledge transfer: short-circuiting the learning cycle? In *Proceedings of the 39th Annual Hawaii International Conference on System Sciences*, page 149b, Washington, DC, USA: IEEE Computer Society.

Sarker, Sa., Sarker, Su., Nicholson, D., and Joshi, K. (2003). Knowledge transfer in virtual information systems development teams: an empirical examination of key enablers. In *Proceedings of the 36th Annual Hawaii International Conference on System Sciences (HICSS '03)*, pages 10-19, Washington, DC, USA: IEEE Computer Society.

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