Interacting with 3D Learning Objects

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Abstract

This paper discusses initial findings that have resulted from ongoing work in the development of a platform for constructing and manipulating learning objects that include three-dimensional elements (3DLOs). We have produced a set of criteria for selecting appropriate immersive platforms and also have started a collection of 3DLOs, for which we have emphasized the importance of interaction with 3D elements to promote significant learning. We have developed strategies for mapping 3DLOs and fostering interaction in the particular context of one immersive environment (Second Life).

1. Introduction

Learning Objects (LOs) [1] are being widely used to support instructional processes, since they integrate not only the specific content for a topic of interest, but also allow the description of the objectives, prerequisites, competences, tasks and activities, as well as evaluation process. As for the design of LOs that handle tridimensional representations in an interactive form, which we will refer to as 3D learning objects (3DLOs), we believe they can help improve concept comprehension as well as motivate learners to participate and explore objects. Nonetheless, investing time and resources in the creation of an interactive 3D virtual environment is not sufficient to guarantee successful collaboration or learning. Overall effectiveness depends on the design and implementation of LOs that will enhance the learning process. Smith et al. [2] noted that, in this context, the proper specification of LOs during the design stage leads to the most significant impact on the potential interaction.

The design and development of 3DLOs is not an easy task for those participating in the teaching-learning process, as they involve both instructional design and technical abilities. Moreover, there is a need for an infrastructural availability to make its implementation feasible in distributed learning environments. Prior research, as documented by [3], has shown that 3D virtual environments can be of aid for learning through direct experience by visualizing concepts and performing tasks enhanced by virtual worlds that are better suited to the learning tasks. However, implementing a 3D environment entails more than enhancing the appearance and improving the usability of a virtual collaboration area. It is also an opportunity to foster a sense of identity and membership within a community among the users [4]. In order to harness the interactive and collaborative features of 3D virtual worlds, an embedded platform [5] is required to develop and implement LOs. The challenge lies in taking advantage of the properties of a 3DLO in a virtual environment to foster collaboration and improve the quality of learning [6].

In immersive environments (such as those reviewed briefly in the next section) much work has focused on generating realistic or believable scenarios. More often than not, however, users continue to be mere spectators and are not allowed to act upon the objects represented in scenarios or to explore cause-effect phenomena. Our work focuses on providing more interactive features to 3DOs, as we share the view that significant learning is associated more strongly with doing and causing phenomena to occur than with just visiting and watching 3D scenarios, however dynamic or realistic they may be.

As a result of our research, a set of criteria for selecting appropriate immersive platforms was outlined. A repository of 3DLOs that emphasizes the key importance of interaction for 3DLOs to promote significant learning was devised. Second Life [7] was selected as the immersive environment for developing and testing our 3DLOs; thus, strategies for promoting interaction are given in that particular context. This platform provided us with a 3D collaborative environment, allowing us to focus on the usability and design of 3DLOs to shorten the development time.

2. Related work

The concept of a virtual world is an exciting new medium for HCI professionals focused on distance learning and distributed collaborative work [5]. The
ideal virtual environment application provides an environment where the user can interact freely within a simulated 3D space [2]. When 3DLOs are used within collaborative, multi-user environments, their learning advantages are enhanced.

Lively [8] was a virtualized chat environment developed by Google that was installed as a plug-in for popular web browsers. It allowed interaction with other participants in user-developed environments, relying on the avatar concept as a representation of the user’s presence within the virtual world. Objects in this world were predesigned and users could interact with them in a variety of potentially useful ways. Unfortunately, the Lively project was closed in December of 2008. A new project was started to continue with Lively’s original idea. It is currently in an early development stage and is no longer sponsored by Google [9].

Vivaty [10] has an interface similar to that of Lively, but can only be used in the context of Facebook or AIM (AOL Instant Messenger). The plug-in is heavier and it takes longer to completely display all the objects inside a virtual room. New objects cannot be modeled or exported to Vivaty.

Wonderland [11] is currently the only immersion environment that allows for the development of objects and scenarios as well as for modifying its source code. The tool is 100% Java-based and X3D objects can be imported, but interaction with them must be programmed using Java. Wonderland has a client-server architecture that can work on several computers at a time.

Second Life (SL) [7] is an environment in which virtual worlds can be created by its own residents. Like Lively, users also are represented by avatars, which increases their sense of identity. SL is arguably the most popular virtual world today, as it already has millions of registered users. The process of developing new objects is carried on within the same environment, and SL provides various tools for defining their physical properties and behaviors.

After reviewing and comparing existing virtual environments (Table 1), we decided that SL would be best suited for the development of 3DLOs. While designing a 3D collaborative environment, careful consideration must be made when deciding the level of detail and interactivity, as well as the performance and usability to meet each object’s goals. We have found that SL provides a relative balance between reality, expressivity, performance and interactivity. Moreover, SL is an environment that runs on a wide variety of platforms and supports multiple communication types, such as text, voice and physical interaction with 3D models.

3. Learning objects in a 3D world

Considering recent progress in 3D technologies, the introduction of the concept of 3D learning contents seems to be the next logical step in the development of LOs. As noted earlier, the use of 3D contents allows learners to manipulate, explore and interact naturally with the objects, doing this with a greater degree of realism, reaching beyond 2D representation capabilities. 3DLOs should help overcome limitations of most online learning materials, which often are just digital adaptations of textbooks and classroom materials [6] and lack the potential 3D online interaction can offer.

A 3DLO can be defined as an object that includes 3D contents with a predefined behavior, which promotes specific competences while taking advantage of its interactive capabilities and immersive qualities. The basic components [12] that make up a 3DLO are listed below (see Figure 1):

- **3D content**: shape and visual characteristics of the object.
- **Learning objective**: knowledge that the learner should be familiar with after completing the interaction.
- **Requirements**: prerequisites for the learner to be able to use the object.
- **Competences**: abilities that must be acquired by the learner.
- **Tasks**: actions to be performed while interacting with the object.
- **Evaluation**: implicit or explicit means for assessing whether goals have been achieved by the learner while interacting with the LO.

### Table 1. A comparison of virtual worlds.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Lively</th>
<th>Vivaty</th>
<th>Wonderland</th>
<th>Second Life</th>
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<td>Linux</td>
<td>Solaris</td>
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<td>5</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td><strong>Objects Handling</strong></td>
<td>(1-5)</td>
<td>3</td>
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<td>Blender</td>
<td>Director</td>
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<td><strong>Performance</strong></td>
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The most important characteristic of 3DLOs we want to emphasize is interactivity. Thus, design should ponder the interactive capabilities of both the object and the virtual environment in which it is going to be immersed. Some of these capabilities include: touching, moving, exploring, annotating and triggering behaviors. In this paper we underline the interactive characteristics of the objects. More information regarding the pedagogical design and the object’s development methodology can be found in [12]. While designing a 3DLO, it is also important to keep in mind that, just like a basic LO, a 3DLO must be adaptive, reusable, scalable and distributable.

5. Preliminary results

In order to demonstrate the validity of our approach, for the last few months we have been working on three prototypical SL-3DLOs. These prototype 3DLOs belong to different study areas, namely chemistry, physics and architecture and focus on chemical synthesis, projectile motion, and Greek architecture orders, respectively. For each of them a storyboard was drafted prior to its construction, allowing for a better outline of the interaction scripts.

The first 3DLO (projectile motion, Figure 2) provides a representation of a basketball court. It aims to allow the learner to modify the angle and strength parameters to have a better grasp of their impact on the trajectory of the ball according to the laws of gravity. The court was modeled for demonstrating possible trajectories and at the same time evaluating the learner’s progress; the goal of the learner is to score.

A second object has been devised for the learner to visually appreciate the process of a simple chemical synthesis (Figure 2), going from ethanol to acetaldehyde. This 3DLO provides a textual explanation and asks for the learner’s input (touching)
to decide which components will be modified in order for the synthesis to take place, before showing the actual transformation.

The third 3DLO has to do with architecture (Figure 3) and was designed to aid in reviewing the characteristics of three different Greek column orders. The learner’s avatar can walk around the columns, representative of each order, and use various viewing options. If the column is touched, learners may show what they know about the columns or enquire and obtain textual information.

6. Work in progress

The next step for our project is to assess the impact that 3DLOs have in learners. Until now, only usability tests have been applied to learners to determine if the 3DLOs have been properly defined and designed. This is of particular importance considering that the intent and purpose expected of 3DLOs have not been formally defined in previous work. Questionnaires were applied before and after usability studies to gather as much information as possible regarding real time interaction with the objects. This information will be used to improve interaction design and to provide with guidelines for future development of 3DLOs.

Preliminary results show that learners believe handling 3DLOs is engaging, and that they would like to use these types of learning resources as means of reinforcing knowledge obtained in traditional classroom lectures. When asked the reason for this, learners mentioned that manipulating visual representations helped understand abstract concepts. Learners also believed their interaction could have been richer had they previously worked within SL classroom lectures. When reinforcing knowledge obtained in traditional learning resources as means of reinforcing knowledge obtained in traditional classroom lectures. When reinforced knowledge obtained in traditional learning resources as means of reinforcing knowledge obtained in traditional classroom lectures. When reinforced knowledge obtained in traditional learning resources as means of reinforcing knowledge obtained in traditional classroom lectures. When reinforced knowledge obtained in traditional learning resources as means of reinforcing knowledge obtained in traditional classroom lectures. When reinforced knowledge obtained in traditional learning resources as means of reinforcing knowledge obtained in traditional classroom lectures. When reinforced knowledge obtained in traditional learning resources as means of reinforcing knowledge obtained in traditional classroom lectures. When reinforced knowledge obtained in traditional learning resources as means of reinforcing knowledge obtained in traditional classroom lectures.

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References