



Discovering usage behaviors and engagement in an Educational Virtual World



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ABSTRACT

This paper explores data retrieved from an Educational Virtual World to identify and validate behavior and usage patterns and engagement indicators. This data exploration is intended not to validate pre-defined questions or specific goals (for example, a comparison between engagement and academic scores) but to discover usage trends and obtain insights about users' usage of the system and their knowledge of and proficiency with the available resources and features. The engagement indicators and knowledge obtained from the analysis of these indicators regarding the users of the system, their desires, and their competencies with virtual resources will facilitate decision-making and planning by managers of the Virtual World to improve system adoption and learning effectiveness, correct usage mistakes, perform actions to enhance user exploitation of available features, and provide information to users on system usage. This knowledge and the actions based on it are capital in an eLearning ecosystem such as an Educational Virtual World, where students are able to perform tasks in 3D at any time or location without supervision.

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1. Introduction

User perception and engagement with technology is a key aspect of a successful technological system, regardless of application. Information about user perception and engagement can be used by system developers, administrators, designers or managers to adapt, enhance or modify the technology to improve user acceptability, interest, feedback or performance. This type of research and analysis has a major presence in the field of eLearning. Within this field of online learning, behavioral and engagement analysis could be used to propose, implement and correct various types of platforms that enable education and skills acquisition via the use of Internet-based technologies. Many authors (Beer, Clark, & Jones, 2010; Krause, 2005; Zhao & Kuh, 2004) have explored the field of behavior analysis and engagement related to online learning environments as a tool to determine how users *feel* and use technology to obtain insights into the acceptance and adaptation of these eLearning ecosystems in the Learning Process and increase success.

Tracing behavior patterns and measuring engagement on these platforms enables the determination of user interest in certain

features or content and whether these features are exploited properly. These measurements enable platform managers to make decisions, correct unexpected uses, promote specific content, perform actions to avoid dropouts, improve system adoption, and adapt the structures or content of eLearning platforms to users.

An educational environment appropriate for this type of study is an Educational Virtual World. This type of environment provides an interesting field of study of user behavior and engagement because it is based on user interaction with a 3D environment and with other users. This feature, combined with the representation of the user via a virtual *alter ego* and features such as text-based chats, voice-based chats or movement between different islands or lands, allows users to express themselves very differently compared to other educational environments (De Freitas, 2006; De Freitas & Neumann, 2009). Thus, user preferences and desires in the field of Learning are often reflected more accurately than in other eLearning ecosystems.

The goals of this research were to measure engagement indicators specific to the Educational Virtual World, identify user behavior patterns (e.g., the correct use of resources and dropout patterns), determine the relationship between engagement factors and the behavior patterns identified in the proposed case study, and relate the observed rules and patterns to possible actions and decisions by Educational Virtual World managers (in case of usage error patterns, dropouts, etc.).

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To achieve these goals, this research aims to conduct an exploratory analysis of a dataset retrieved from an Educational Virtual World to identify usage patterns, engagement factors and user behaviors to provide insights into the perceptions and motivations of users about a technology such as an Educational Virtual World.

The paper is divided into the following sections. Section 1 introduces the problem and concepts that will be discussed in the paper. Section 2 presents the data that will be analyzed and describes the retrieval process. Section 3 provides deeper insight into the variables used in the analysis and the challenges that this analysis attempts to address. The Section 4 describes the behaviors and patterns detected in the exploratory data analysis, while Section 5 discusses these behaviors and patterns, validating or rejecting the results as appropriate. Finally, Section 6 presents several conclusions regarding the research and potential future extensions.

2. Materials and methods

2.1. Facilities

To develop this research work, we used an Educational Virtual World developed by the University of Salamanca. This Virtual World, called USALSIM (Lucas, Cruz-Benito, & Gonzalo, 2013), is designed to provide virtual practices and *immersive* learning experiences through a 3D environment. In 2012, a series of 3D environments permitting the development of professional practices and learning in the following areas of knowledge were incorporated into USALSIM: Pharmacy, Biology and Biotechnology, Law, Humanities and Chemistry. The type of activity varies depending on the specific needs of each area of knowledge and practice; some require personal work by each user (pure interaction with 3D scenarios inside the Virtual World), while others require more discussion or role-playing tasks (interaction with other users).

This virtual world was developed under the platform known as OpenSimulator or OpenSim (OpenSimulator, 2014). This open-source platform allows the managers of the Virtual World (in this case, developers at the University of Salamanca) to control all data related to users and the 3D environment, enabling a thorough analysis of the selected data, in contrast to other Virtual Worlds (like Second Life for example) that do not allow the retrieval and analysis of detail in such detail.

Microsoft Excel was used to extract raw data (only organized in parameters and not modified) from the Virtual World for exploratory analysis. Using this software, we performed a manual analysis based on clustering of common features and measures of users and the use of basic statistics to analyze the measures. Automatic methods were not used for the analysis because this study was primarily an exploratory analysis and was intended not to address pre-defined questions but to develop findings related to the research goals.

2.2. Data analyzed

For this study, data representing different characteristics and areas of usage were retrieved from the USALSIM Educational Virtual World and analyzed separately and in combination to identify user interests, behavior patterns or engagement measures.

As many authors have noted, Virtual Worlds feature a strong social use component (Borner & Penumarthy, 2003; Messinger et al., 2009), and even in those Virtual Worlds that implement learning activities, users often interact with each other, whether required by the educational task (such as role-playing activities) or not.

The data used were collected in two months, between November and December 2012, during testing prior to deploying this Virtual World to the general student population at the University of Salamanca. These preliminary tests were intended to study

student acceptance of the Virtual World (Fetscherin & Lattemann, 2008), its relevance to education in the University and its effectiveness for skills acquisition and content learning. After the tests, both teachers and students assessed aspects of appropriateness and acceptability through surveys (Lucas et al., 2013). For this research, the authors do not intend to evaluate the acceptance or effectiveness of the platform for learning or its specific use by users during the test months, which could be determined using surveys after the pilots or based on student grades, but the authors do intend to explore user behavior and usage patterns to obtain deeper knowledge and explore the value of this knowledge in decision-making processes about the learning process in this Virtual World.

The tests involved 75 users, and data were collected on various aspects that might indicate usage characteristics, behavior and engagement indicators in the Virtual World. These 75 users were classified as follows:

- *One system administrator*: This user was not included in the collection and analysis of data because the number of actions performed in the 3D environment and the time used in the system introduced too much noise in the data set.
- *Ten teachers*: These teachers were labeled differently in the analysis to identify potential differences in behavior between teachers and students.
- *Sixty-five students*: Students in the various knowledge areas described above (Pharmacy, Biology and Biotechnology, Law, Humanities and Chemistry) volunteered to try this new learning environment at the University. Because the testing stage was more focused on knowledge about use and engagement, the analysis did not differentiate among the knowledge areas of the students.

Data concerning four of the key features and options in Educational Virtual Worlds (Cruz, Therón, Pizarro, & García-Peñalvo, 2013) were retrieved: voice chat-based features, text communication-based features (between users, messages between objects, etc.), session information (time in each, total number, average time, etc.), and movement inside the Virtual Worlds (between different lands, islands, etc.). These features were chosen for analysis because they provide a range of information about users' desires, interests, usage patterns, or habits in both Educational Virtual Worlds and other eLearning Systems (Beer et al., 2010; Dalgarno & Lee, 2010; Fetscherin & Lattemann, 2008):

- *Voice API calls*: Data on the number of times the 3D characters used the voice service within the Virtual World. These data provide information about communication only between users and can reveal certain social characteristics (Borner & Lin, 2001; Borner & Penumarthy, 2003).
- *Messages with objects and users*: Data on the number of times that 3D characters made use of private messages to each other or received information from the different objects in the virtual environment. These data provide information on both social use, such as the 3D scanning environment, and the use of educational resources (Schmidt & Laffey, 2012).
- *Sessions*: Data about the time spent by users within the Virtual World and its distribution in time, number of sessions, average session duration, etc.
- *Movements*: Data about the movement patterns of users. The number of movements may be an indicator of engagement, while movement to a specific territory may indicate interest in that territory (Cruz-Benito, Therón, García-Peñalvo, & Pizarro Lucas, 2013; De Freitas, 2006).

Data about other indicators, such as clicks in 3D contents or objects, text discussion themes, changes in avatar appearance,

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