Examining Young Learners' Activity Within Interactive Virtual Environments

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Abstract

This research sets out to explore children's interaction in immersive Virtual Environments (VEs), focusing on the role and the effect of interactivity on learning and conceptual change. The intention is to examine how interaction and conceptual learning are related in the context of virtual environments developed primarily for informal educational settings. In order to study this, a set of exploratory studies was carried out with children aged 7-12. The children were asked to complete tasks, such as the assembly of ancient columns from parts, which were designed to promote constructivist learning. Their interaction in the VE was analyzed using an Activity Theory framework [3]. The result of this analysis has informed the design of the main studies, which is currently underway.

Keywords: Interactivity, learner-computer interaction, conceptual learning, virtual reality.

MOTIVATION AND BACKGROUND

The plethoric development of interactive systems for children, the proliferation of immersive exhibits in museums, informal education institutions and entertainment settings, and the growing sophistication of home gaming systems, emphasize the appeal of interactivity, regarded as the process with which users can have a first-person experience: act upon, control, and even modify their own digital experience. In these contexts interactivity is being promoted widely, not only for its recreational potential but also for its significance for learning. This is even more prominent in the case of immersive Virtual Reality (VR), since interactivity is largely regarded as one of VR's essential properties. There is a common belief that the effectiveness of a VE that provides a high degree of interactivity is substantially more than the effectiveness of a VE where interactivity is not present. However, little systematic research is available to substantiate this assumption and, to date, no clear evidence exists that interactive VR applications can bring "added value" to learning, especially for children. Furthermore, it is not certain if interactivity alone, as an essential property of the virtual reality medium, can provide a strong effect upon learning. This problem is particularly acute where deep understanding, not behavior, is of concern. Hence, a central question emerges: does interactivity enable learners to construct meaning? This research is interested in examining the dimension of interactivity in a VR experience and, in particular, its potential and limitations for learning.

IDC 2004, June 1-3, 2004, College Park, Maryland, USA

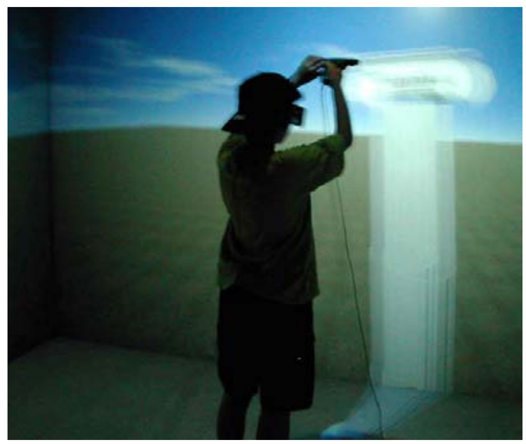

Figure 1. A young user engaged in a column construction activity during the exploratory studies aimed at examining interactivity in an immersive virtual environment.

PILOT STUDIES

A set of exploratory studies was carried out with three children between 8 and 12 years old. The children were asked to complete tasks, such as the assembly of ancient columns from parts, in an immersive stereoscopic VE (a CAVE®-like display) using a 3D joystick device with buttons for interaction. We observed the children's activity in the VE and looked for the following different occurrences of learning for the purpose of analyzing our data:

- Conceptual change, where participants revise their conceptions or change their interpretation of something.
- Additive knowledge, where participants have added to what they have already experienced, as long as this involves some kind of reinterpretation of previous action rather than just the accumulation of information.

- Changes in behavior. Despite the constructivist focus of our study, changes in behavior were considered an important indication of learning simply because they were more likely occur in the observational data of such a small study, than strong evidence of some internal understanding.

Our method of analysis was based on supporting or refuting emerging hypotheses; we reviewed the video of all sessions and identified various points where interesting interactions seemed to occur [1]. We then proposed a hypothesis concerning what we saw, explaining this in terms of learning. We chose to focus on points where participants made a statement that indicated they had changed their belief or where we could conclude things from our observation of the subject's behavior in the environment. The organizational framework of Activity Theory [3] provided us with the conceptual vocabulary to help interpret these points qualitatively. Our findings indicated instances where the following kinds of learning took place: learning about the system as a result of technical problems, learning caused by (unintentional) observer intervention and, to a lesser extent, learning arising from system feedback. In the latter case, we focused on excerpts where instances provoking internal contradictions leading to conceptual change seemed to occur. These caused the subjects to change their behavior as well as revise their rules and conceptions, triggered by the rules set out by the system. The subjects' observation of the system's rules guided them in evaluating their actions, assessing for themselves the contradiction within the system and resolving it in order to achieve the objective.

The pilot case studies set out to explore the research question (how to provide evidence that interactivity influences learning) and succeeded in clarifying issues concerning the methodology for working with children for this problem and the framework for analysis. They also allowed shortcomings of the task to be identified; the observed learning outcomes indicated that the learning goal of the tasks, as designed, was not clear and did not provide enough opportunities for conceptual learning to occur and, consequently, to be assessed. This led to a re-design of the study.

NEXT STEPS

Since what is sought is evidence of conceptual change arising from a process of scaffolding and feedback generated by the system, the experiment tasks require re-designing to focus on achieving such change and minimising the other kinds of learning, such as technical learning or learning as a result of external aid from the observer.

Additionally, a different learning domain has been chosen in order to exploit the capabilities of the VR medium in visualizing abstract and difficult conceptual learning problems and providing feedback. Hence, in order to examine "interactivity", varied levels of control over the parameters of the system will be provided through an experimental VE in which children will be asked to complete constructivist tasks (such as planning the layout of a playground) that are designed as mathematical ***fraction*** problems. Fractions are chosen as learning topics due to the difficulty that primary school students have in understanding and connecting them to real-world situations [2]. The tasks will involve modifying (resizing and placing) the various elements of the playground according to rules that require fractions calculations. The system will provide intrinsic feedback to respond to the children's activity, including feedback on the rules of the task provided by an intelligent agent. The experimental method will include observation, interviews and pre- and post-test questionnaires, designed in collaboration with math teachers, for three different participant groups (two experimental and one control).

Figure 2. An early snapshot of the virtual environment used for the main studies, in which children will interactively design a playground based on the rules that will be provided in the form of *fractions*.

ACKNOWLEDGMENTS

The author wishes to thank Professor Mel Slater and Dr. Martin Oliver for their valuable insights and supervision.

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