Virtual Experiment Environment’s Design for Science Education

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ABSTRACT

We present the educational possibilities of the Web based virtual experiment (VE) environments in the science education. As there are a lot of things that cannot be experimented with in the lab among the contents of experiment of science education, there are a lot of difficulties in the teaching-learning process. Therefore, we have developed virtual experiment environments on the Web designed to be compatible to the learner levels through level analysis in the learning contents. The students can select the learning level in the exploring step of learning cycle model: regular, advanced and remedial courses, according to the degree of their understanding or interest about the learning topic. The virtual experiment environments will support students to learn scientific phenomena and concepts focusing on: radiation balance, the earthquake waves, the earth’s crust structure, the movement of sea water, and solar system in the science field of middle school. The VE environments have been evaluated to the responses of learners on a Web. This study shows that the Web-based VE environments in science education can be effectively used as a virtual class.

Keywords: learner-centered learning; science education; virtual experiment environment’s design, web-based virtual experiment

INTRODUCTION

Today there is an increasing number of educators abandoning predominantly didactic, lecture-based modes of instruction and moving towards more learner-centered models in which students are engaged in problem solving and inquiry (Land & Hannafin, 1996; Mclellan, 1996; Stratford, Krajcik & Soloway, 1998). Along with this, the present advanced technology is providing the various new learning environments where the students can expand their understanding and make a challenge themselves (Barab et al., 1998; Mclellan, 1996; Olson, 1998; Winn, 1995).

However, in the school environment, there are a lot of difficulties in conducting the inquiry and experiments of science education in reality due to various problems such as the problem of students’ movement, highly expensive experimental equipment, and the problem of not being able to explore or observe the inside of the earth or the universe by themselves. Especially for the tasks that are difficult to show in the real world, the dangerous experiment tasks, the tasks that have the effect when showing them in a 3D mode, and the tasks...
that cost a lot, a 3D mode can be as a method to overcome these problems.

The virtual reality (VR) technology is one of these methods. Virtual Reality technology is expected to bring a lot of change to the present educational environment. Furthermore, it is judged that the subjects such as the earth science in science education above all will be the primary subject of the application. Since the earth science is the subject targeting nature including the celestial body, the ocean and rocks and so forth, it is important to find the fundamental principles while conducting various inquiries in the actual situations of nature. For instance, if you use the VR technology, you can directly visit the Sun. The learners can conduct the observation of the celestial body, which is usually impossible due to the limitations of time and space and the high cost.

In terms of using the learning materials, this VR environment is not restricted by the limit of physical space and the limit of time, and so forth. Therefore, all learners can take part in the learning anywhere and anytime. Besides, if the learner uses the VR environment, the learner gets the sense of reality that is almost at the same level as the actual reality even as to the transformation of the internal structure of the crust. And as for the VE environment embodied through the VR environment, though the beginners make mistakes, they can try again without a burden, and it gives not only the sense of reality but also high interaction. Such interaction is very useful in understanding the concept or the principles of a matter (Byrne, 1993; Winn, 1995; Youngblut, 1998).

VR means fully immersive worlds created by computers but it can be extended to semi-immersive and non-immersive (desktop) VR. In spite of the disadvantage of non-immersive VR systems, the non-immersive VR systems are by far the most common in the present because they are not only cost effective but also can be used in the network environments. Therefore, it is judged that we can overcome a lot of difficulties in conducting the inquiry and experiments of science education to some degree if we use the excellent physical environments such as the established educational computer network and ultra high-speed information communication network and the education system utilizing the 3D VR technology.

This paper presents the Web-based VE environments of the earth science for the middle school students that are using the advantages of the currently established ultra high-speed educational computer network. To this end, first, we describe the virtual reality as an educational tool. Second, we develop the VE environments for the Web-based learning of earth science education in middle school. Finally, we discuss the response of learning in the VE environments.

VIRTUAL REALITY AS AN EDUCATIONAL TOOL

The latest trend of education is based on the constructivism in which the learners can participate in the learning in a self-leading way and compose their knowledge in their own meaningful way. In such learning based on the constructivism, it is important to provide the learners with the learning environment. Recently, technological advances make possible new types of learning environment, moving from transmission models where technology functions like textbooks, films, or broadcasts to environments in which the technology functions like studios and laboratories in which students immerse themselves within interac-
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