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Investigation of effects of virtual reality environments on learning performance of technical skills

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ABSTRACT

Practical training is what brings imagination and creativity to fruition, which relies significantly on the relevant technical skills needed. Thus, the current study has placed its emphasis on strengthening the learning of technical skills with emerging innovations in technology, while studying the effects of employing such technologies at the same time. As for the students who participated in the study, technical skills had been cultivated in the five dimensions of knowledge, comprehension, simulation, application, and creativity, in accordance to the set teaching objectives and the taxonomy for students learning outcome, while the virtual reality learning environment (VRLE) has also been developed to meet different goals as the various technical skills were being examined. In terms of the nature of technology, operation of machines, selection of process parameters, and process planning in technical skills, VRLE has also designed the six modules of "learning resource", "digital content", "collaborative learning", "formative evaluation", "simulation of manufacturing process", and "practical exercise" in particular for providing students with assistance in the development on their technical skills on a specific, gradual basis. After assessing the technical skills that have been developed for the time period of one semester, the students have reported finding VRLE to be a significantly effective method when considering the three dimensions of "operation of machines", "selection of process parameter", and "process planning", though not so much so when it came to the dimension of "nature of technology". Among the six modules, "simulation of manufacturing process" and "practical exercise" were the two that were most preferred by students for the three dimensions considered.

1. Introduction

The technology of virtual reality (VR) is a product generated by the intertwining applications of image editing, graphic designing, and multimedia (Knott, 2000). It is capable of making simulations of the reality in cyberspace and creating three-dimensional images that possess highly educational values (Johari, 2005; Saleeb & Dafoulas, 2011; Wasson, 1997). Virtual reality enables a learning environment in cyberspace that is more versatile than the traditional "chalk-and-blackboard" classrooms in that learning takes place as individuals make exchanges of technological interactions either with other individuals or with whatever systems/softwares used; the application of virtual reality in education is a great leap of teaching methods after the multimedia, computers, and the Internet. The most commonly used formats of such virtual teaching environment include virtual technical skill training, virtual laboratory, virtual instructions, virtual campus, and virtual distance learning.

1.1. Study on virtual-reality learning environment & core theories

In distinguishing the teaching styles, the core of the first generation of computing-assisted learning lies in analyzing how to build a virtual learning system, environment, and content just so to better have knowledge spread (Gordin & Pea, 1995). The core of the second generation of computing-assisted learning focuses more specifically on ways of building appropriate learning styles as well as ways of allowing learning processes to be outlined with the convenience that comes with informative technologies available, and this is so that the learner is able to have the newly acquired knowledge internalized (Dede & Lewis, 1995). The design of virtual-reality learning environment being investigated in the present study places even a higher premium on context-aware computing, with its concentration transformed from spread of knowledge to formation of knowledge, and then to "one-on-one" style of learning, while the theories on learning have been transformed simultaneously.

The transformation of computer-assisted learning from "resources" to "competency" has been a complex and difficult process that went through five phases (Beckman, 1997) (see Table 1).

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Table 1
The five layers of knowledge (Beckman, 1997).

1. Data	Original text, fact, coding, image, sound
2. Information	Organized and systemic information that has been interpreted and summarized
3. Knowledge	Case study, rule, equation, model
4. Expertise	Timely and accurate suggestions; interpretation and defense of results
5. Capability	Organizational skills, knowledge base, comprehensive production-driven system support, core capabilities

Advancing to one level up at each of the stage requires a certain degree of cognitive machining. For instance, the realization of transformation of information into knowledge requires reasoning, abstract thinking, formation of associations, and practical applications. It should be pointed out that the cognitive activities outlined by Beckman are usually carried out on campuses in different formats, and they appear to be closely associated with teacher–student interactions. As a study on cultivating the higher order functions has found, when the cognitive capabilities and social interactions are integrated sensibly it is when learning effects are the greatest. In fact, the sociocultural theory has explicitly specified that dialogues that take place in a learning environment play a significant role in defining the sociological viewpoints that a learner internalizes. Consequently, it is not just the effects that are produced on formation of meaning by cognition that deserves more attention than it has been getting but also even more so would be the values that the external social world places on the transformations of knowledge.

This point of view has also gained tremendous support from Brown, Colins, and Duguid (1989) and other scholars. Such practical knowledge as skills and concepts is situational and its formation is most effective and meaningful when such formation takes place in a setting where social and physical situations and interactions intertwine. Brown et al. has proposed that through cognitive apprenticeships the learner's skill becomes honed and perfected to an expert level. The effectiveness of the cognitive apprenticeship model emphasizes on learning in context and this is highly corresponsive to what in cognitive psychology has been termed "distributed cognition", which places its emphasis on the coordination between individuals, artifacts, and the environment (Dede & Lewis, 1995), and this supports the development of an environment that is based on information communication technology.

1.2. The virtual reality learning environment and technical skills education summarized

Studies conducted on virtual learning environments in recent years have focused increasingly on sciences of learning, by looking at the studies that have been done internationally there seem to exist issues in the following five aspects: The fundamental theories that the virtual reality environments are based on, for one (E.g. Burdea & Coiffet, 2002; Furlong, Vance, & Larochelle, 1999; Rickel & Johnson, 1998); secondly would be the teaching and learning of the virtual reality environments (E.g. Johari, 2005; Moreno & Mayer, 2000; Salzman, Dede, Loftin, & Chen, 1999); third, the initiatives taken on the use of the different kinds of virtual-reality based environments (E.g. Alvarez & Su, 2009; Bierbaum et al., 2001; Elliott & Bruckman, 2002); four, the assessments done on the learning outcomes made possible in virtual reality environments (E.g. Antonya & Talaba, 2007; Chen, Chen, & Kinshuk, 2009; Rizzo et al., 2000); five, the multi-faceted cultural elements and the sexual equality that are involved in the learning processes (E.g. Cromby, Standen, & Brown, 1995; Smedley & Higgins, 2005); and six, studying of the students' emotions and affections, cognitions, and behaviors (E.g. Amorim, Trumbore, & Chogyen, 2000; Patera, Draper, & Nael, 2008; Yee & Bailenson, 2007).

In sum, the following conclusions may be made: (1) theories that are used are fundamentally based on structuralism and situational constructions, meaning to analyze the principles of designs along with the relative computer programming of the virtual reality environments in the lights of sciences of learning; (2) the methods for teaching and learning are largely based on situational constructing, and such methods are compared against the traditional teaching methods, as well as against the virtual reality teaching–learning environments of various types; (3) the discussions on virtual reality environments have been oriented basically toward the desktop virtual-environment type, the advanced virtual-reality environment type, the immersive virtual-reality type, and finally, the distributed virtual-reality type of such environments; (4) the measurements taken for assessments conducted on virtual reality environments applied to the students have been based on the students' cognition, emotions and affections, and the changes that they have made in their concepts or behavior; (5) the cultural elements and sexual equality concerned are relatively innovative fields of study for scrutiny, with the emphasis mainly focused on special education; and (6) emotions and affections, cognition, along with behavior of the students are also what are being concentrated on for the current thesis. Some researchers (Patera et al., 2008) created a virtual reality environment (VRE) to stimulate motivation and creativity in imaginative writing in students. The impact of VRE on the educational activity was evaluated through a formal assessment of the stories by an independent marker, with quantitative and qualitative analysis of the stories conducted; observations and interviews had also been given jointly with the teachers. As the results of the study have shown, while the students have displayed high levels of motivation and interest as they were situated in a virtual-reality driven learning environment both the teachers and the students are in the stage where they still need to acquire better adaptability on such applications.

Concerning the professing of technical skills, technology education has been defined by Yang (1992) as: "a rational education plan, by which learners can develop technical skills, learn technical principles, and intelligently apply these skills and knowledge in modern life". In this way, learners can also develop the ability to make appropriate value judgments of contemporary and future technology, which can help them easily adopt future highly-developed technology. Therefore, we have to first verify the content of technological literacy and then teach this content through a well-planned curriculum and activities (Lee & Yang, 1999). They developed the tool to be used for quality control on the testing skills and the relative index system, which includes the scope of technology, the evolution of technology, the process of technology, the application and evaluation of technology, and the impact of technology.

2. Research method

2.1. Objectives and Issues

The several issues that are scrutinized in a more concrete form in this research are the following: (1) Whether virtual-reality learning environments are facilitating to college students' training of technical skills; (2) The effects produced by the taxonomy designed for this study on the students in their senior year of college; (3) the various levels of proficiency of technical skills cultivated; (4) the different modules that make possible of the technical skill proficiencies.

2.2. Instruments

To find out the most accepted module for use by the students, one set of means of measurement used was paper-and-pencil