

A feasible group testing framework for producing usable virtual reality learning applications

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Abstract Designing a usable learning application is one of the key factors in ensuring effective learning. This article introduces modified group usability testing (MGUT) as a feasible framework for evaluating the usability of non-immersive virtual reality (VR) learning applications. Conventionally, usability testing of such learning applications often employs the one-to-one approach in which an evaluator conducts testing with several individual participants. As opposed to the one-to-one approach, the group approach involves several-to-many participants performing tasks simultaneously, with several evaluators observing and interacting with participants. This article describes the complete step-by-step procedure for conducting MGUT to uncover usability problems of a VR learning application that aims to educate its users on fire safety and prevention. It also proposes methods to analyze these usability problems. The effectiveness and efficiency of MGUT was then compared with DGUT, the original group testing technique and cooperative evaluation (CE), which is a typical one-to-one approach. Results indicate that all three techniques are able to reveal usability problems of different usability factors and show similar capability to discover the most critical and serious problems. MGUT is more effective than DGUT as it can collect additional usability problems of various factors and of different levels of severity. MGUT is as effective as CE as both techniques can identify usability problems which are more or less comparable in terms of quantity and quality. As for efficiency, MGUT and DGUT

are more efficient than CE as these group testing approaches require lesser testing time, lesser effort in terms of the intensive interaction with participants although with slight more effort in the preparation of the physical setting. In addition, it is also obvious that MGUT and DGUT involve richer participation than CE. MGUT is also more feasible than DGUT as it allows some flexibility in the computer arrangement setting.

Keywords Virtual reality · Human–computer interface · Group usability testing · Interactive learning environments

1 Introduction

Virtual reality (VR) offers unique learning experiences due to its ability to provide real-time three-dimensional visualization and afford various types of interactivity within virtual learning environments. Many researchers have pointed out the significance of utilizing VR technology for engaging learners in their learning process, and to date, VR-based applications are ubiquitously used in various educational contexts (Bricken and Byrne 1993; Dalgarno and Lee 2010; Freiberg and Mahalinga-Iyer 2005; Ferk et al. 2003; Merchant et al. 2014; Ouyang et al. 2004).

Generally, there are two main types of VR, namely immersive VR and non-immersive VR (Kalawsky 1993). This article focuses on the non-immersive VR system where such system presents an interactive real-time three-dimensional virtual environment on a conventional computer screen, and the user can interact with it using generic devices, such as mouse or keyboard. Many non-immersive systems are also internet-based. Non-immersive VR is relatively low cost as it does not require additional peripherals, and this makes it feasible for ubiquitous

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