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Learning Scope of Python Coding Using Immersive Virtual Reality

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Abstract. Programming is a highly sought-after technical skill in the job market, but there are limited avenues available for training competent and proficient programmers. This research focuses on evaluating an immersive virtual reality (VR) application that has been introduced in the field of Python learning, which uses the interaction technique and a user interface, allowing the novice to engage in VR learning. 30 participants were recruited for the evaluation purpose and they are divided into two groups--15 for Experiment I, and 15 for Experiment II. A questionnaire to evaluate the user interface was done in Experiment I, and a questionnaire to evaluate the novice's acceptance of the VR application was given to the participants in Experiment II. Furthermore, interviews were conducted to collect detailed feedback from all the participants. From the results, it can be noted that the implemented interaction designs in this VR application are adequate. However, more interaction techniques can be integrated to increase the degree of immersive experience of the user in the application. Besides, the interface of the application is considered adequate and reasonable. Nevertheless, there is room for improvement in the aspect of usability and provide a higher level user experience. The novices' acceptance level of the new proposed learning method is low; this might be due to the users' fear of change-- a normal human behaviour in embracing new things in life. Therefore, a larger sample size is proposed to further investigate the novice's acceptance of the new learning method by using an improved version of the VR application.

Keywords: Immersive Virtual Reality, Education, Programming Learning.

1 Introduction

Virtual reality (VR) has become a popular medium of application for various fields such as entertainment [1], [2]; education [3], [4], [5]; medical training [7], [8], [9]; mental health monitoring and development [10], [12]; and military training [12], [13], [14]. VR in education and learning tools are designed for students to acquire academic concepts in the virtual reality environment. Scenarios that represent the psychological feeling of being in the VR world, realism and level of reality are used to measure the user experience [15]. Realism is the user's expected response to the stimuli, and the perceived experience of the virtual environment (VE) [16], [17] that will vary according to the degree of reality in interacting with the virtual components presented.

Programming has been identified as a crucial skill for career success in innumerable disciplines and sectors, but it is quite a daunting task to master various types of programming languages. Based on IEEE Ranking Spectrum, the top five programming languages are Python, Java, C, C++, and R language [18]. The motivation of students in learning programming depends very much on the availability of effective tools to resolve the problems mentioned above [19]. Insufficient understanding of the executed programs is a major factor that will cause students to struggle in learning programming. Inability to grasp the fundamentals of writing computer programs will soon lead to discouragement; negative attitudes may set in, and students may become demotivated towards learning the subject of programming. According to Edori [20], the enthusiasm of students is considered as a top learning factor because it has a direct impact on their perseverance and dedication in completing their goals. Types of interactions provided in the VR application must contain interesting elements that can increase the enthusiasm of students toward Python learning. There are various advantages and disadvantages of implementing VR in education as shown in Table 1. According to Sherman and Craig [21], mental immersion refers to the deeply engaged state within VE, and sensory immersion refers to the users' movement, vision, auditory and haptic sensations when they are engaged in the scene changes of VE; these sensory immersion responses are essential for successful and enjoyable interacting experiences in the VE.

Table 1. Advantages and Disadvantages of VR.

Advantages of VR	Disadvantages of VR
Highly motivated the user [22]	Costly [23]
Encourage active participation rather than passivity [23]	Safety effect [23]
Learner-centered [24]	Possible reluctance dealing [23]
Promote Higher Order Thinking Skills [24]	Spatial awareness

The five basic human senses should be involved for a complete immersion feeling in the virtual environment. However, sight is the most important sense and it is the most closely allied with reason [25], so it is natural and normal for the VR environment to focus on sight and hearing only. Research of gauging the VR effects on the brain functions and the user experience using the electroencephalogram-based evaluation method shows that the motor, cognitive or other functions of the brain are influenced by the virtual environment [26]. The graphics and content nature of VE cause changes in the aforementioned brain processes which have the effect of influencing the user experience. Therefore, an immersive VR system that is capable of isolating the user from the real world is able to provide the highest level of immersion and increase the task efficiency; but at the same time, it is the most expensive among the three systems [27]. Since VR can be applied to interdisciplinary education systems, immersive VR is employed in this research. The VR learning environment is further extended with animation and multimedia for a richer experience. It is becoming a more popular and powerful media for student usage in schools [28]. Huang, Liaw, & Lai [29] studied the user acceptance of implementing 3D VR in learning based on the perceived usefulness and perceived ease of use, as rated by the user. The results show that 3D VR encourages positive learning attitudes if the learner perceived these two things: the system is a useful tool for learning; and it must be easy to use. Fig. 1 shows the final model of the learner's attitude towards 3D VR learning.