Library Progress International *Print version ISSN 0970 1052*
Vol.44 No.3, Jul-Dec 2024: P. 26648-26654 *Online version ISSN 2320*

Original Article *Available online at www.bpasjournals.com*

Designing Scaffolding in Virtual Reality Environment for Learning

Siti Hazyanti Mohd Hashim[1], Ahmad Sufril Azlan Mohamed [2]

[1,2] School of Computer Sciences, Universiti Sains Malaysia, Pulau Pinang, Malaysia.

How to cite this article: Siti Hazyanti Mohd Hashim, Ahmad Sufril Azlan Mohamed (2024) Designing Scaffolding in Virtual Reality Environment for Learning. *Library Progress International,* 44(3), 26648-26654

ABSTRACT:

Learning styles offer insights into how students focus on and retain knowledge. Traditional classroom experiences primarily revolve around textbooks, which can be challenging to comprehend and may lead to reduced student engagement. In response to this challenge, virtual reality proves to be a potent tool for boosting motivation and learning in the classroom. To tackle this problem, the integration of the Scaffolding technique within an interactive virtual reality environment, simulating real-world scenarios, becomes particularly pertinent, especially in fields like computer science. This approach enables students to engage in practical, immersive learning experiences that closely mimic real-world applications. The overarching objective is to design educational learning using virtual reality games, tailored to the needs of higher education students. This approach aims to motivate and enhance learning outcomes, fostering a more engaging and effective educational environment.

KEYWORDS:
Scaffolding, Education, Virtual reality technology

Introduction

According to [1] computer science courses, particularly those that focus on programming languages and algorithms, are recognised for presenting substantial difficulties to students within this discipline. Presently, the predominant focus in conventional educational environments is on preparing for assessments, engaging passively in lectures instruction, and attempting to mentally grasp historical content sourced from textbooks. According to [2], the emphasis on formality, theory, and reliance on books in these learning approaches may deplete students' ability to maintain attention and concentration. An additional factor contributing to the challenges encountered in the process of learning is to the implementation of theoretical concepts in practical settings, as observed in both classroom and laboratory sessions [3]. Virtual reality has emerged as a potentially beneficial tool in education, augmenting the interest and involvement of students across a range of academic disciplines [4]. Virtual reality is a technological innovation that enables the digital representation of tangible items found in the physical world [5]. The process entails the use of computer modelling and immersive three-dimensional technology to generate a visual and sensory environment in three dimensions, facilitating user interaction [6], [7], [8] Virtual reality applications utilise interactive devices to facilitate the transmission and reception of data, thereby immersing users in computer-generated environments that closely resemble reality [9], [10].

1) Virtual Reality in Education

As indicated in [11], virtual reality education is perceived as a safer, more economical, and efficient alternative to traditional education, mainly due to its ability to significantly shorten training times [12]. Incorporating virtual reality can enrich classroom experiences and extend learning opportunities at all educational levels. According to [13], the use of virtual reality in educational settings has the potential to greatly enhance student motivation and active participation in the learning process. Moreover, government backing, including funding for research, talent development, content creation, and the promotion of responsible use, could further unlock the full potential of immersive technology [14], [15]. The field of educational and training activities acknowledges virtual reality as a technology with significant potential and quick progress [16]. The implementation of this technology has resulted in favourable outcomes, such as heightened levels of participation, enhanced motivation, and improved learning efficiency. According to [17] touch screens and laptops are frequently used media platforms by students, while the accessibility of virtual reality devices is on the rise.

Virtual reality environments offer the potential for students to explore fictional scenarios, thereby stimulating their imagination and promoting the development of creative thinking skills. A significant advantage of incorporating virtual reality technology in education is its ability to enhance the learning process, resulting in increased student engagement and interest [18]. In the field of computer science, virtual reality is employed to improve the educational experience of undergraduate students, particularly in enhancing their proficiency in Python programming. The main goal of this initiative is to complement and enrich traditional teaching methods, such as in-person lectures and hands-on lab activities.By employing a dynamic and participatory game-based methodology, students have the opportunity to acquire proficiency in Python programming, while potentially augmenting the entire educational milieu. The ongoing advancement of the project will generate significant interest in its efficacy [1].

2) Previous Research

In contemporary times, there has been an increasing inclination towards investigating benefit of using three-dimensional technology for delivering beneficial educational interventions in the realm of computer sciences [19]. The integration of virtual reality technology in educational environments presents educators with the potential to include game-based instructional approaches, such as engaging design, which is gamification, and serious games, resulting in an enriched experience for students [20]. Furthermore, scholarly investigations have demonstrated that pupils using a virtual reality game-based programme exhibited enhanced cognitive benefits and had more positive dispositions toward the acquisition of knowledge [21].

The current research explores the potential use of Virtual Reality Escape Rooms as a teaching tool in biology education. It specifically examines how these VR-based Escape Rooms compare to instructional films with narrative components in terms of their effectiveness. The research comprised a sample of 50 students enrolled in upper-secondary education, namely from the applied science track. According to a study conducted by [20], the utilisation of virtual reality Escape Rooms as a form of active learning resulted in superior short-term information acquisition when compared to the passive learning approach of utilising movies.

This brief analysis investigates virtual reality technology on its utilisation in surgical education. The utilisation of virtual reality technology presents an advantageous and economically viable approach to imparting surgical expertise and investigating surgical methodologies. The present study centres on the development of three-dimensional simulations of organs within the body and surgical paths through the utilisation of virtual reality technology. The text finishes by suggesting the creation of a full ecosystem to facilitate the implementation of surgical training using virtual reality technology [22].

A study was conducted to evaluate how three-dimensional learning affects academic performance in mathematics. The study employed a quasi-experimental methodology, wherein a treatment group

consisting of 32 students utilised a virtual reality game, while a comparison group of 32 students employed conventional techniques, including the usage of mobile apps for fractions. According to the findings of [23]. The utilisation of virtual reality gaming has been linked to improved academic performance and sustained student engagement in the realm of mathematics.

A formative assessment was conducted to explore the impact of a virtual reality expedition application on the computational thinking skills of higher education students. Six participants were randomly selected, and a mixed research methodology was employed. The qualitative analysis revealed that the participants found the virtual reality mini-games to be very interactive and engaging, leading to a significant enhancement in their computational thinking abilities. Research has indicated that the incorporation of a cohesive gameplay experience within educational environments has been shown to augment students' aptitude for computational thinking. Furthermore, the integration of virtual reality explorations has been observed to cultivate curiosity and facilitate long-term knowledge retention among students. In a study conducted by [19], [24]. was observed that users had a significant increase in information acquisition and perceived the mini-games as being conducive to educational purposes.

3) Scaffolding Technique in Learning

Scaffolding has a key function in aiding the educational process of students. From opinion of [25], as learners gain greater independence, the level of help offered through scaffolding is steadily diminished. Scaffolding is an instructional method that has significant value and may be effectively implemented in diverse educational environments, including those that incorporate game-based learning. According to [26], the provision of assistance aids learners in achieving enhanced learning outcomes and fostering a happy learning experience.

Integrating teacher scaffolding into game-based learning is an essential interactive approach designed to improve student learning outcomes. The utilisation of adaptive assistance within educational settings has been shown to have several positive effects. Firstly, it enhances students' enthusiasm and engagement, leading to increased levels of active participation. Moreover, it serves to enhance the comprehension of intricate subjects and promotes a more profound grasp of the educational goals. Visual aids are commonly used as scaffolding techniques in game. According to [27], active engagement is fostered and students are able to establish connections between the game and real-life applications.

In the context of education, scaffolding is defined by three key characteristics which are contingency, fading, and a transfer of responsibility. Contingency is engagement provided to learners dependent on their level of competence. This adjustment is commonly implemented in educational games through the incorporation of adaptivity. The process of fading entails a progressive reduction of help provided to learners as they demonstrate increased competence. Ultimately, there is a transition in which learners progress from relying on external assistance to engaging in self-directed learning. These attributes play a crucial role in promoting effective learning, particularly in game-based educational settings [28].

4) Designing Scaffolding Education Game

5)

The development of an educational virtual reality game encompasses three fundamental elements: a conceptual framework, a storyboard, and a flowchart.

(a) Conceptual framework
(b) Storyboard
(c) Flowchart

(a) Conceptual Framework

The research's conceptual framework encompasses various essential elements, such as the educational prerequisites of higher education, the elements of gaming, components of virtual reality, pedagogical principles in education, and the selected learning model [29]. The framework presented in this study has been constructed by integrating existing literature and incorporating insights obtained from the current research.

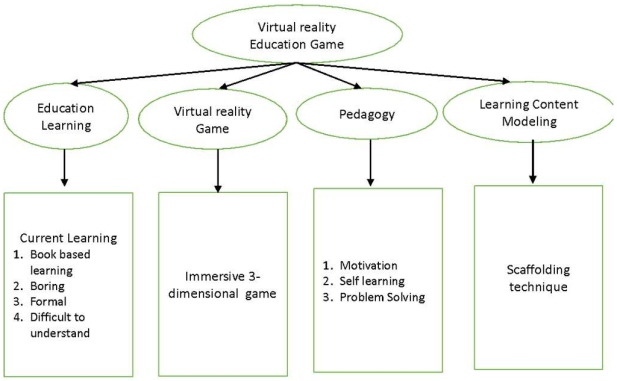

Figure 1(a) Conceptual Framework

(b) Flowchart

The flowchart starts with an explanation to the participants regarding the purpose, design, and methodology employed in the study. Participants are required to respond to a set of questions or complete an exercise both prior to and after engaging with virtual reality technology, in order to facilitate a comparison of the scores obtained. The participants will acquire knowledge in the subject matter while utilising the Oculus virtual reality technology. Upon the conclusion of the virtual reality game experiment, participants are required to respond to the post-exposure questionnaire pertaining to the virtual reality game, as well as the usability test questionnaire.

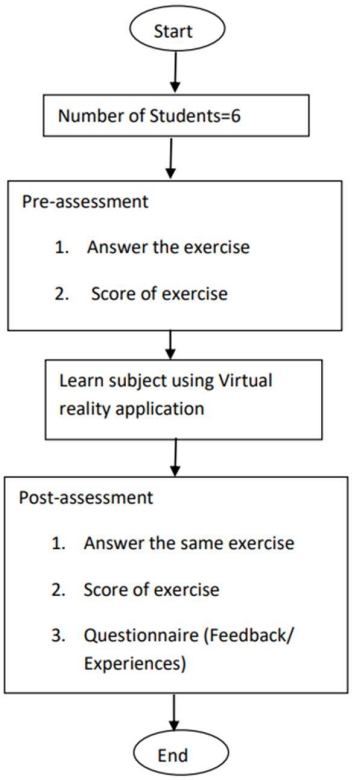

Figure 1(b) Flowchart

6) Significant

Virtual reality games represent a new technological advancement in education. The game's elements, genre, and type are crucial for engaging players, capturing their interest, and enhancing their enjoyment of the game. Game level, which is the challenge between level, is important in the development of the game to measure that it is not too easy to make it boring and not too difficult to frustrate. Designing a 3-dimensional environment in the virtual reality game helps players get involved in the game. Virtual reality game in education is helpful in motivating students due to having an interactive, interesting, fantasy-occupied and challenging game. Besides, the students could improve their learning as they are well immersed in the game. Using 3-dimensional virtual reality game acts as a new way to improve a student's skill in learning. The virtual reality environment will give the students a new environment that they can feel real while wearing the Oculus and doing exercises. In addition, the virtual reality game design will be used at home.

7) Conclusion

The research contribution is to use the scaffolding learning style model by integrating virtual reality technology. By utilizing an interactive virtual reality environment, this strategy is feasible and can be implemented not only in higher education institutions but also at all educational levels.

8) Acknowledgement

The authors are grateful to Universiti Sains Malaysia for funding this research with the grant number:
Short term grant: 304/PKOMP/6315801

9) Data Availability

No new data were created or analyzed in this study. Data sharing is not applicable to this article.

10) Conflict of interest: The authors declare that there is **no conflict of interest.**

References

[1] Srimadhaven, T., Chris Junni AV, Naga Harshith, and M. Priyaadharshini. "Learning analytics: Virtual reality for programming course in higher education." *Procedia Computer Science* 172 (2020): 433-437.

[2] Widyasari, Widyasari, Hadi Sutopo, and Murniati Agustian. "QR code-based learning development: Accessing math game for children learning enhancement." (2019): 111-124.

[3] Ochoa, C. "Virtual And Augmented Reality In Education. Are We Ready For A Disruptive Innovation In Education?." In *ICERI2016 Proceedings*, pp. 2013-2022. IATED, 2016.

[4] Burov, O. Yu, and Olha P. Pinchuk. "A meta-analysis of the most influential factors of the virtual reality in education for the health and efficiency of students' activity." *Educational Technology Quarterly* 1, no. 2023 (2023): 58-68.

[5] Fitria, Tira Nur. "Augmented reality (AR) and virtual reality (VR) technology in education: Media of teaching and learning: A review." *International Journal of Computer and Information System (IJCIS)* 4, no. 1 (2023): 14-25.

[6] Hashim, Siti Hazyanti Binti Mohd, Marina Binti Ismail, Haidzir Bin Abd Manaf, and Fazah Akhtar Binti Hanapiah. "Framework of virtual reality game on dual cognitive task for stroke rehabilitation." In *2018 IEEE Symposium on Computer Applications & Industrial Electronics (ISCAIE)*, pp. 114-118. IEEE, 2018.

[7] Hazyanti, "Usability of Interactive 3-Dimension Virtual Reality Game on Dual Cognitive Task for Stroke Rehabilitation," *Int. J. Adv. Trends Comput. Sci. Eng.*, vol. 9, no. 1.2, pp. 117–126, Apr. 2020, doi: 10.30534/IJATCSE/2020/1891.22020.

[8] Hashim, Siti Hazyanti Mohd, Marina Ismail, Haidzir Manaf, and Fazah Akhtar Hanapiah. "Development of dual cognitive task virtual reality game addressing stroke rehabilitation." In *Proceedings of the 2019 3rd International Conference on Virtual and Augmented Reality Simulations*, pp. 21-25. 2019.

[9] Miljkovic, Ivana, Olena Shlyakhetko, and Solomiia Fedushko. "Real estate app development based on AI/VR technologies." *Electronics* 12, no. 3 (2023): 707.

[10] Wiboolyasarin, Watcharapol, Nattawut Jinowat, Kanokpan Wiboolyasarin, and Ruedee Kamonsawad. "Digital school or online game? Factors determining 3D virtual worlds in language classrooms for pre-service teachers." *Interactive Learning Environments* (2023): 1-18. [11] A. Shoshani, "From virtual to prosocial reality: The effects of prosocial virtual reality games on preschool Children's prosocial tendencies in real life environments," *Comput. Human Behav.*, vol. 139, p. 107546, Feb. 2023, doi: 10.1016/J.CHB.2022.107546.

[12] Hashim, Siti Hazyanti Mohd. "Interactive Education with Exploration Virtual Reality Technology." *Journal of Electrical Systems* 20, no. 7s (2024): 1222-1229.

[13] Mohd Hashim, Siti Hazyanti, Nurul Farhana Nasir, and See Tao Hoong Jyn. "Entrepreneurship Education Through Three-Dimensional Virtual Reality Technology in Learning." In *International Conference on Entrepreneurship, Business and Technology*, pp. 679-688. Singapore: Springer Nature Singapore, 2022.

[14] Karutz, Cody O., and Jeremy N. Bailenson. "Immersive virtual environments and the classrooms of tomorrow." *The handbook of the psychology of communication technology* (2015): 290-310.

[15] Rojas-Sánchez, Mario A., Pedro R. Palos-Sánchez, and José A. Folgado-Fernández. "Systematic literature review and bibliometric analysis on virtual reality and education." *Education and Information Technologies* 28, no. 1 (2023): 155-192.
[16] Parmaxi, Antigoni. "Virtual reality in language learning: A systematic review and implications for research and practice." *Interactive learning environments* 31, no. 1 (2023): 172-184.
[17] Lorenzo, Gonzalo G., Nigel N. Newbutt, and Alejandro A. Lorenzo-Lledó. "Designing virtual reality tools for students with Autism Spectrum Disorder: A systematic review." *Education and Information Technologies* 28, no. 8 (2023): 9557-9605.
[18] Marougkas, Andreas, Christos Troussas, Akrivi Krouska, and Cleo Sgouropoulou. "Virtual reality in education: a review of learning theories, approaches and methodologies for the last decade." *Electronics* 12, no. 13 (2023): 2832.
[19] Agbo, Friday Joseph, Solomon Sunday Oyelere, Jarkko Suhonen, and Markku Tukiainen. "Design, development, and evaluation of a virtual reality game-based application to support computational thinking." *Educational technology research and development* 71, no. 2 (2023): 505-537.
[20] Christopoulos, Athanasios, Stylianos Mystakidis, Enrique Cachafeiro, and Mikko-Jussi Laakso. "Escaping the cell: virtual reality escape rooms in biology education." *Behaviour & Information Technology* 42, no. 9 (2023): 1434-1451.
[21] Agbo, Friday Joseph, Solomon Sunday Oyelere, Jarkko Suhonen, and Markku Tukiainen. "Design, development, and evaluation of a virtual reality game-based application to support computational thinking." *Educational technology research and development* 71, no. 2 (2023): 505-537.
[22] Ntakakis, Georgios, Christina Plomariti, Christos Frantzidis, Panagiotis E. Antoniou, Panagiotis D. Bamidis, and Georgios Tsoulfas. "Exploring the use of virtual reality in surgical education." *World journal of transplantation* 13, no. 2 (2023): 36.
[23] Akman, Emrah, and Recep Çakır. "The effect of educational virtual reality game on primary school students' achievement and engagement in mathematics." Interactive Learning Environments 31, no. 3 (2023): 1467-1484.
[24] Jingili, Nuru, Solomon Sunday Oyelere, Frank Ojwang, Friday Joseph Agbo, and Markus BT Nyström. "Virtual reality for addressing depression and anxiety: a bibliometric analysis." *International journal of environmental research and public health* 20, no. 9 (2023): 5621.
[25] Finali, Zetti, Afib Rulyansah, and Fajar Surya Hutama. "Multiple intelligences-based instructor scaffolding strategies in digital game-assisted mathematics instruction." In *AIP Conference Proceedings*, vol. 2679, no. 1. AIP Publishing, 2023.
[26] Chang, Chi-Cheng, and Szu-Ting Yang. "Interactive effects of scaffolding digital game-based learning and cognitive style on adult learners' emotion, cognitive load and learning performance." *International Journal of Educational Technology in Higher Education* 20, no. 1 (2023): 16.
[27] Sun, Liping, Marjaana Kangas, Heli Ruokamo, and Signe Siklander. "A systematic literature review of teacher scaffolding in game-based learning in primary education." *Educational Research Review* 40 (2023): 100546.
[28] Faber, Tjitske JE, Mary EW Dankbaar, Rob Kickert, Walter W. van den Broek, and Jeroen JG van Merriënboer. "Identifying indicators to guide adaptive scaffolding in games." *Learning and Instruction* 83 (2023): 101666.
[29] Hashim, Siti Hazyanti Mohd. "Framework of Metaverse Educational Learning of Virtual Reality Environment in Improving Current Learning Problem." In *2023 IEEE 8th International Conference on Recent Advances and Innovations in Engineering (ICRAIE)*, pp. 1-10. IEEE, 2023.