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Learning Analytics: Virtual Reality for Programming Course in Higher Education

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Abstract

The conventional teaching styles are monotonous and fail to help all the levels of the students to achieve the expected competencies of the course; thereby lack the motivation. With the advancement of educational technology and the urge to engage learners of the 21st century, it is necessary to shift the classroom paradigm of higher education embedded with the new innovative teaching styles. With the use of ICT for education, the teaching-learning processes are streamlined with smart classrooms equipped with collaborative activities and the course instructors take advantage of available free online ICT tools and cloud services for higher education.

The courses like mathematics, programming language and algorithms are very challenging for the students of computer science engineering and even for the students of other departments. To provide better teaching strategies for addressing this challenge, the objective of this ongoing project is to adopt VR for teaching programming courses. The first-year undergraduate students from all the departments practice common Python course with the same teaching style and assessment pattern. This course teaching style includes traditional classroom teaching embedded with practice questions for each topic in the laboratory. To explore the new teaching style, a Virtual Reality mobile game is introduced to the learners of the first year. Few sessions experimented with the virtual reality mobile app for assessing the cognitive level of the students in the Python course. This virtual reality mobile app is designed with a maze game pattern of three stages. The learners need to find all the right doors to open the path inorder to reach the final place. Each door is embedded with challenging time-based Python questions that are arranged in the form of random activities like complete code, debugging, jumble code and drag & drop. All the activities are given scores based on the correct answers and wrong answers will reduce the timer for solving the questions. Each stage has variations with easy, medium and expert levels. The higher levels are entrenched with more challenging activities with higher-order thinking.

The students are motivated to learn Python programming in the form of virtual reality mobile games. The final score determines the level of the learners and the cognitive skills acquired in this course. This type of teaching-learning style will also help the course instructors to identify the slow learners who score less marks in all the levels or many attempts. This technique uses MALAR rubrics for PCC model as an evaluation pattern in the course. The MALAR rubrics include identifying the problem solving, creative thinking and critical thinking

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skills of the learners. The limitations with the adoption of this strategy is to ensure the use of VR based console in the classroom or rent it for the students as these activities cannot be experienced without VR console. The cumulative scores of the students are analyzed using a reinforcement learning technique. The reward points are given to the learners based on the successful attempt of solving the Python questions and every unsuccessful attempt will add negative scores. The overall mark determines the award points of the learners. The cognitive levels of the learners are analyzed using the learning analytics like the clustering algorithm. This clustering algorithm is framed by using rubrics score and reinforcement rewards points. This analysis helps the faculty to understand the cognitive level of the learners, competency skills, emotions of the learners of adopting VR techniques and slow learners in the Python course.

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Keywords: Virtual Reality, ICT, Learning Analytics, Rubrics, Reinforcement Learning.

1. Introduction

Virtual Reality(VR) is aninnovative technology to create a three-dimensional environment, interactive, real-time platform and the user can interact with the platform and get real-world experiences. In recent years, VRhas become popular in many fields.The adoption VR for higher education has gained alot of popularity and opportunity for the academic institutions to explore the benefits of VR for the teaching-learning process. The VR environment detects a user's input in the form of gesture, thestudents can view the activity in the app or consoleandresponds to the task. VR can be adopted as one of the innovative pedagogical techniques to actively involve the Gen Z learners in real-world experiences. Many of the courses are challenging for the students to learn, comprehend and analyze the concepts, their motivation behaviour is affected and they score low marks in academics. Another challenging issue in the teaching-learning process are the practical and hands-on experiences [2] of the concepts during the classroom and laboratory learning sessions. A various fields like the mechanical, civil, bio-medical, medical field, military training are difficult to explore and gain practical experiences. Even computer science courses like algorithms, mathematics related algorithms, programming language are very challenging for the students to understand the concepts. Virtual reality [5] can aid in these challenging issues and give real-world hands-on experiences for the students. The virtual platformwill provide a safe environment to test concepts or task which are difficult or dangerous to perform in real life. It helps all the levels of the learners to comprehend the concepts easily and gain an experience of reality.It helps the learners to activate the cognitive learning skills to actively engage in the process of thinking and to engage in the effective learning process.

VR can be used to make the learning process more interesting and engage the learners with fun activities to motivate and improve academics grades. The universities and colleges can adopt such innovative pedagogical models without the constraints of expensive lab setup and safety issues. The head mount display (HMD) [6] and other VR console is required along with the 3D experience platform or mobile app to bring the VR into the reality of classroom teaching. It is time-consuming and requires some funding or budget to incorporate in the academic institutions. When the common VR platform and lab setup is established, it can be used to develop for various courses according to the needs of the course and personalize for the benefits of the learners.

2. Proposed Work

The objective of this research work is to apply and analyse the effectiveness of virtual reality for under-graduate students of higher education. The proposed architecture for the virtual reality for programming course in higher education is given in Figure 1. The first years B.Tech students undergo the common programming course namely "Problem Solving and Programming" across all the departments. This programming course includes Python programming. A common pattern of teaching styles, assessment process and evaluations is adopted for this course. This course is a laboratory based course where the faculty teach the concepts followed by the practice sessions in the laboratory with higher-order thinking skills. The students make use of the online interactive portal to practice, test the code and submit it for the evaluations. All the practice tests, assessments, challenging tasks, multiple-choice questions, debugging and evaluations are done using this portal. This traditional teaching style will be embedded with VR console experiences by the studentsand yield better cognitive skills.

The classroom environment is made interactive with the head-mounted display (HMD) and each student is given an opportunity to experience the virtual reality based mobile games. The cognitive skills is identified using MALAR rubrics for PCC model to measure the problem solving, creative thinking and critical thinking skills. The affective behavior is determined using sentiment analysis. The self-efficacy and self-regulated behavior are identified with the performance improvement in each of the virtual reality sessions. The motivation of the slow learners and enhancing the academic performances of the students can be achieved through an innovative teaching style. For all the performance analysis metrics, learning analytics plays an essential role to collect measure and analyze the learner's behavior. Reinforcement learning is chosen as ananalysis to assign the reward points for the learners based on correct or incorrect activities. The overall score project the learner's performance of adopting VR for a programming course.

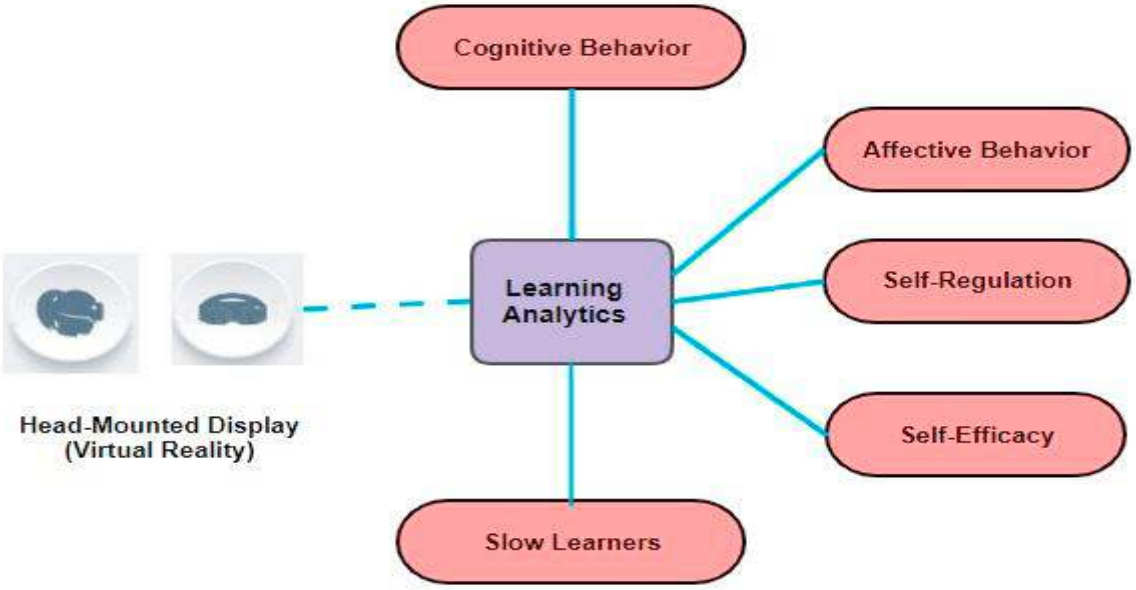

Figure 1 : Architecture of Virtual Reality methodology

3. Results and Analysis

This research project will be developed using unity software which is open source 2D/3D development software. The reinforcement learning and Learning analytics analysis is done using Python notebook which offers a flexible library for machine learning algorithms. The visualization of the analysis can also be done using thePython library. This learning analytics will give insight into the learner's affinity and interest in virtual reality by sentiment analysis. The cognitive behaviour and competency skills are measured using the rubrics metrics. With the innovative and student-centric approach, this study also helps to measure the self-efficacy and self-regulating behaviour of the students. The scaffold of pedagogical models will motivate slow learners and enhance their academic performance.

4. Conclusions

The student-centric pedagogical model is adopted for under-graduate students of higher education. The classroom teaching is embedded with the VR platform to actively involve the learners to improve their cognitive skills and achieve better grades with good academic proficiency. This research work focussed to enhance the learner's performance with VR techniques for the programming course of first-year engineering students across all the departments. The learning experiences help to measure the cognitive skills using rubrics evaluation and affective behaviour using sentiment analysis. The slow learners' behaviour and learning path are also tracked and guided for motivated self-regulated learning skills. The art of self-learning is also encouraged in this research work with continuous active participation. The learning analytics aids the teaching-learning process with reinforcement learning and clustering algorithms. The results can be used to utilize ICT for higher education and enhance the performance of all levels of the learners.

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