An Experimental Study on Computer-Based Virtual Classroom Learning, and Its Impact on Student Performance Based on Sri Lankan University Students

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Abstract - Virtual Reality (VR)-based platforms have the potential to bridge the existing gap between educationalists and students. Computer-based simulators have the ability of Virtual Reality (VR), and it has a potential to take learning beyond the traditional online teaching-learning experience of educationalists and students together in the same room with the aid of online learning tools. VR-based educational applications were introduced to the market recently with the advancements and rapid growth of the pandemic to face 'new normal' ethics. VR-based simulators allow students to visualize or immerse the concepts taught in classroom textbooks, whether the student is at home, the library or anywhere in the world. In the global framework, many student learning reforms are initiated. However, modern VR learning delivery technologies, VR training methods, and gamification technologies are not yet addressed in Sri Lanka. Further, VR technology's influence on student performance is not profoundly studied in the Sri Lankan university context. Therefore, it is important to conduct an experimental study to find the student's mental behaviour, especially with the academic performance in the virtual paradigm. The research was developed via quantitative research techniques as a pre-post experimental study to achieve the research objectives with Quantitative data collection methods. Further, descriptive statistical analysis approach based on paired t-test analysis method was used and data analysis was done via IBM SPSS statistical tool. The main variables identified as Knowledge of Structures, Feedback, Mental Models and the conceptual framework were designed based on literature for the t-test. As pre-test, students were given a questionnaire to fill before the simulator training treatment. The questionnaire was designed based on available literature, while there were three-hypotheses based on the variables. The chosen VR learning platform was 'Unimersiv' ancient Rome visit for the students, and that lesson gives a great knowledge on ancient history. After the simulator learning, the same set of students was given the post-test questionnaire to fill. Significant correlation analysis proved that there is a positive and direct effect of each independent variable mentioned above.

Keywords: virtual reality, learning, simulators, experimental study

I. INTRODUCTION

Transfer of information or knowledge has been a priority for civilizations since the beginning. From ancient history to today education is the basement for society, and People are constantly looking for ways to make knowledge transfer more easily, more quickly, and more effectively (Alexander, Westhoven and Conradi, 2016). Universities have always first innovated cutting edge of new technologies and tools, driving or directing students on development and preparing the next generation of developers, scientists and entrepreneurs. Virtual and augmented reality technologies are at the frontier of development right now (Connable et al., 2019).; the market is forecast to reach $13.9 billion in 2017 (IDC), and change is happening at a frenetic pace. Virtual Reality (VR) has the potential to transform the way we learn and teach, from providing in-depth knowledge and helping us understand complex subjects to facilitating language immersion and virtual trips (Fletcher, 2009).. It's already widely used in global schools for younger children, but we're

seeing its use more and more in higher education for a variety of reasons, including its ability to enhance learning and help with student recruitment.

In 2021, VR technology using in higher education is not a new or unknown practice. Most of the tutors in universities, business schools and colleges who are already taking full advantage of the VR technology in teaching with illustrating practical and theoretical aspects (Osman, 2018). Virtual Reality (VR) based platforms have the potential to bridge the existing gap between educationalists and students. Computer based simulators have the ability of Virtual reality (VR) has potential to take learning beyond the traditional online learning experience of educationalists and students together in the same room with the aid of online learning tools. VR based educational applications were introduced to the market recently with the advancements and rapid growth of the pandemic to face the 'new normal' ethics. VR based simulators allow students to visualize or immersive the concepts taught in classroom textbooks, whether the student is at the home library or anywhere in the world. In the global framework, many student learning reforms are initiated. However, modern VR learning delivery technologies, VR training methods, gamification technologies are not yet addressed in Sri Lanka.

A. Research Problem

A key advantage of exploitation VR in education is that students learn through experience. VR permits to bring 2D objects to real life and makes visualization via a reality, enabling students to experience the theories practically. Practical consequences are vast, as VR technology opens new traditions to absorb skills that are difficult to teach.

 As per the literature, in the beginning, VR is used in higher education to train students' soft skills. Virtual Speech is being used by universities around the world to improve communication skills essential for employment after graduation. These mentioned skills require representative practice, which is terrible to achieve constantly with the traditional or online teaching methods (Shinn and Habedank, 1992). In the global framework, many student learning reforms are initiated. However, modern VR learning delivery

technologies, VR training methods, gamification technologies are not yet addressed in Sri Lanka. Further, VR technology's influence on student performance is not profoundly studied in the Sri Lankan university context. Therefore, it is important to conduct an experimental study to find the student's mental behavioural especially with the academic performance in the virtual paradigm.

B. Objective

To identify the impact of the simulator-based VR learning on the key factors of academic performance (Knowledge of Structures, Feedback ability & Mental Models) of the Sri Lanka university students.

II. METHODOLOGY

The research was developed via quantitative research techniques as a pre-post experimental study to achieve the research objectives with Quantitative data collection methods. Further descriptive statistical analysis approach based on paired t-test analysis method used and the data analysis done via the IBM SPSS statistical tool. The main variables identified as Knowledge of Structures, Student Feedback, Mental Models, and the conceptual framework designed based on literature for the t-test.

A.   Independent Variables

1)   Knowledge of Structures.

2)   Student Feedback.

3)   Mental Models.
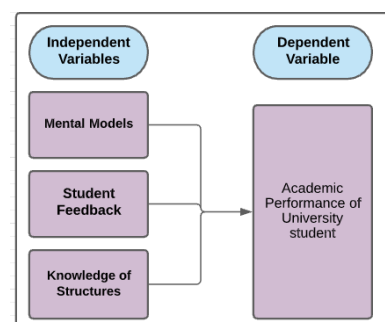
B.   Dependent Variable

Figure 1. Conceptual Framework
Source: Authors

C.   Hypothesis

Formulated hypotheses based on independent variables are as follows:

Hypothesis One. Hypothesis one is as follows:

1)   H1a: There is a difference in mean values (impact in individual performance) of pre and post VR learning platform tests on their knowledge of Structures.

2)   H1o: There is no difference in mean values (impact in individual performance) of pre and post VR learning platform tests on their Knowledge of Structures.

Hypothesis Two. Hypothesis two is as follows:

3)   H2a: There is a difference in mean values (impact in individual performance) of pre and post VR learning platform tests on the Student Feedback.

4)   H2o: There is a difference in mean values (impact in individual performance) of pre and post VR learning platform tests on the Student Feedback.

Hypothesis Three. Hypothesis three is as follows:

5)   H3a: There is a difference in mean values (impact in individual performance) of pre and post VR learning platform tests on the Mental Models.

6)   H3o: There is no difference in mean values (impact in individual performance) of pre and post VR learning platform tests on the Mental Models.

D.   Population

The study was focused on the state of the academic performance of the students after exposure to the modern virtual learning platform. It was highly arguable to select an effective sample population that result in justifiable and generalizable findings to the Sri Lanka university system. Therefore, the researcher selected the government university students in the 2nd year due to the importance of the academic performance was understand by them in the 2nd year of student life as well as its influence over the entire degree program. The size of the population of Sri Lanka government university was approximately 39400(Sri Lanka University Statistics, 2020) during the time of the study.

E.   Sample

The G power 3.1.9.2 program was used to calculate the sample size from the given population. The effect size (d) was set to 0.89 based on past studies on meditation conducted by researchers (Lee and Kang, 2020), the sample size of 385 Based on a priori power analysis by G*Power, Using the parameters of Confidence Level in 95% Confidence Interval 5% Population consider as the number of adults in Sri Lanka, the minimal total sample size was 96 for one group pre and post paired t-test.

III. RESULTS AND ANALYSIS

A. Descriptive Analysis of Gender and Age Factors of the Individuals.

The research was conducted with 96 university students in 6 universities in Sri Lanka. The participants were all under the age of 25 at the time of conducting the research.
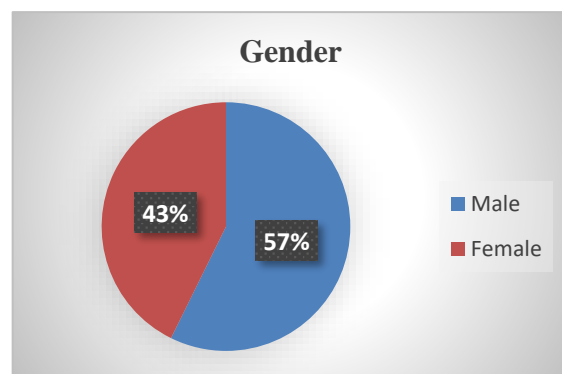

Figure 2. Gender
Source: Advanced Excel - Authors

Results on Questions Categories into main 3 sections. Survey results on question 'A' category to describe the variable of Individual skills/Competence. This category describes the self-estimation level of the skills of each participant which is related to Knowledge of Structures. They have gone through the traditional learning method in pre-test and VR

based learning platform in the post-test and answered the questions in section A which is related Structure of different knowledge levels they experienced with VR platform and traditional methods.
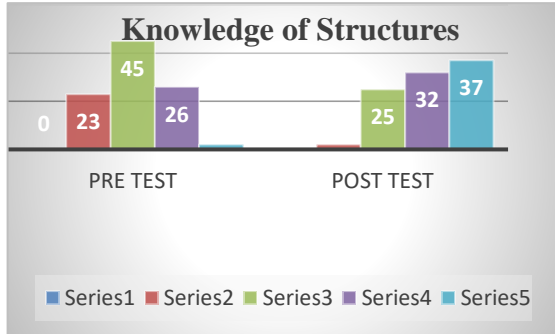

Figure 2. Knowledge of Structures
Source: Advanced Excel – Authors

'B' category to describe the variable of Student feedback relevant to the individual performance by the series of questions after the pre and post-test which related to individual readiness to mentality to learn new things and feedbacks related to the performance estimated by themselves.
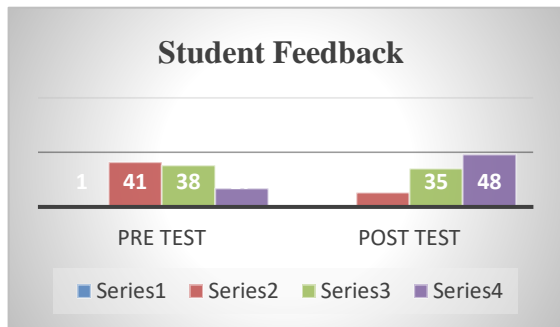

Figure 3. Student Feedback
Source: Advanced Excel – Authors

Results on Question 'C' Category is mainly designed to describe the variable of Mental models for complete the learning tasks accomplishment. By analysing the survey results, there should be a clear understanding of the individuals' Mental models rather than the physical state and their readiness to complete the given learning task accomplishment.
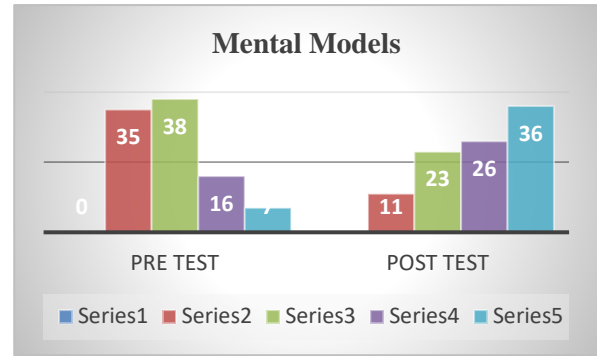

Figure 4. Mental Models
Source: Advanced Excel – Authors

IV. DATA ANALYSIS AND DISCUSSION

A. Correlations Test Results Between Variables

Table 1. Correlations Test Results Between Variables.

		Knowledge of Structures	Student Feedback	Mental Models
(a)		**(b)**	**(c)**	**(d)**
Mental Models	Pearson Correlation	1	.643**	.862**
	Sig. (2-tailed)		.000	.000
	N	96	96	96
Student Feedback	Pearson Correlation	.643**	1	.592**
	Sig. (2-tailed)	.000		.000
	N	96	96	96
Knowledge of Structures	Pearson Correlation	.862**	.592**	1
	Sig. (2-tailed)	.000	.000	
	N	96	96	96
**. Correlation is significant at the 0.01 level (2-tailed).				

Source: SPSS – Authors

The results show that correlation is significant at the 0.01 level. Correlations test results between

variables show a greater than .5 for each compared variable.

This correlation is significantly performed to justify the validity and reliability of selected three variable factors. The result indicates that there is a significant level of correlation between all variables. Correlations test result between, Mental Models, Student Feedback and Knowledge of Structures variables are 0.862, 0.643 and 0.592 respectively, which indicated a strong relationship between the level of integration and other variables. The highest value of Pearson Correlation, which is indicated as 0.862 in Mental Models that has a strong relationship with the dependent variable of academic performance of students.

1)   *Impact on Mental Models over the academic performance of students.*

Pre-post Test Paired Samples Statistics of Mental Models over the academic performance.

Table 2. Pre-post Test Paired Samples Statistics.

		Mean	N	Std. Deviation	Std. Error Mean
	(a)	(b)	(c)	(d)	(e)
Pair 1	Pre-Test - Mental Models	15.84	96	1.951	.350
	Post Test - Mental Models	20.26	96	3.715	.667

Source: SPSS – Authors

The observed difference between pre and post-test is 0.317. The standard error gives the accuracy of a sample mean by measuring the sample-to-sample variability of the sample means.

Table 3. T-test Analysis Results on the Impact Mental Models over the State of academic performance.

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
Pair 1 Pre-Test - Mental Models Post Test - Mental Models	-4.419	3.922	.704	-5.858	-2.981	-6.273	30	.000

Source: SPSS - Authors

Pre-test results of individuals without VR simulators and post-test after exposure to VR simulators indicate in the table above. According to the paired T-test that indicates that Hypothesis H1a is supported with p < 0.05 level. T-value = - 6.273. That is, there was a significant interaction between mental models individuals after exposure to VR simulators. At the Significance level at the P < .05 these results show the Null hypothesis gets rejected since t = - 6.273 and p <0.65 and there is an impact on VR Environment training.

2)   *Impact on Student Feedback on the academic performance of students.*

Pre-post Test Paired Samples Statistics of Impact of the Student Feedback over the academic performance.

Table 4. Pre-post Test Paired Samples Statistics.

		Mean	N	Std. Deviation	Std. Error Mean
	(a)	(b)	(c)	(d)	(e)
Pair 1	Pre-Test - Student Feedback	16.26	96	2.816	.506
	Post Test Student Feedback	20.87	96	3.452	.620

The observed difference between pre and post-test is 0.114. The standard error gives the accuracy of a sample mean by measuring the sample-to-sample variability of the sample means. Paired Sample T-test Analysis Results on Impact of the Student Feedback over the academic performance.

Table 5. Analysis Results on the - Student Feedback over the State of academic performance.

					Paired Differences				
		Mean	*Std. Deviation*	*Std. Error Mean*	*95% Confidence Interval of the Difference*		*t*	*df*	*Sig. (2-tailed)*
					Lower	*Upper*			
	(a)	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*	*(g)*	*(h)*	*(i)*
Pair 1	Pre Test - Student Feedback Post Test - Student Feedback	-4.613	4.688	.842	-6.333	-2.893	-5.478	30	.000

Source: SPSS - Authors

According to the results of the paired T-test that indicate that Hypothesis 1 is supported with p < 0.05 level. T-value = - 5.478 That is, there was a significant interaction of improving Student Feedback after exposing to the VR based learning platform.

3) Impact on Knowledge of Structures over the academic performance of students.

Pre-post-test Paired Samples Statistics of Knowledge of Structures over the academic performance.

Table 6. Pre-post Test Paired Samples Statistics.

	Mean	**N**	**Std. Deviation**	**Std. Error Mean**
(a)	**(b)**	**(c)**	**(d)**	**(e)**

Pair 1	Pre Test - Knowledge of Structures	16.55	96	2.514	.452
	Post Test - Knowledge of Structures	21.10	96	3.902	.701

Source: SPSS - Authors

The observed difference of pre and post-test is 0.25 Standard error gives the accuracy of a sample mean by measuring the sample-to-sample variability of the sample means. T-test Analysis Results on the Knowledge of Structures over the academic performance.

Table 7. Analysis Results on the Knowledge of Structures over the State of academic performance.

					Paired Differences				
		Mean	*Std. Deviation*	*Std. Error Mean*	*95% Confidence Interval of the Difference*		*t*	*df*	*Sig. (2-tailed)*
					Lower	*Upper*			
	(a)	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*	*(g)*	*(h)*	*(i)*
Pair 1	Pre Test - Knowledge of Structures Post Test - Knowledge of Structures	-4.548	4.718	.847	-6.279	-2.818	-5.368	30	.000

Source: SPSS - Authors

Null hypothesis was rejected and the H3a is significantly proved as the difference in mean values of pre and post VR Environment test on their Knowledge of Structures in the t value of - 5.368.

The research goal is to conduct an experimental study about computer-based virtual classroom learning methods and their impact on the study performance of selected university students in Sri Lanka. Study about existing university facilities in Sri Lanka and get an idea about the

impact and ideas to improve VR-based new classroom concepts in Sri Lankan universities in the future. This study supposes practical to evaluate the overall impact and power of digital VR systems related to the university system. The future benefits to the educational industry and facility that estimates to achieve within Sri Lanka were emphasized with the above statistical figures in the Pre and post-test experimental details. The improvements of the current Sri Lankan university educational systems as an entity or educational department could be gain attributed to several renovations and combined with new VR-based digital makeovers with renovations based on the independent and dependant variables of research Mental Models, Student Feedback Knowledge of Structures. There was a comprehensive value indicate in the post-experimental test parallel to the Mental Models over the State of academic performance -6.273, Impact on Student Feedback over the academic performance of students -5.478 and Impact on Knowledge of Structures over the academic performance of students 5.368. The most impacted variable identified as the mental model t-test value -6.273 where VR based learning platform gives visual, auditable, immersion study experience comparing to traditional learning method impact on the human brain.

V. CONCLUSION

According to the quantitative results, the researcher identified that all selected factors have a significant correlation with each other. The significant correlation analysis proved that there is a positive and direct effect of each independent variable have a positive impact on the dependent variable of academic performance. All Null Therefore, the findings of this research proved the academic performance of Sri Lanka university students can be improved by exposing them to modern learning platforms using VR simulators to provide knowledge. Most significantly, this study output provides a baseline for indication to prove that VR is a more appropriate and modern technology for effective teaching on par with traditional teaching practicing in Sri Lanka. The most impacted variable identified as the mental state model t-test value -6.273 where VR-based learning platform gives visual, auditable, immersion study

experience comparing to traditional learning method impact on the human brain. Most significantly, this study results provide a baseline for evidence to prove that virtual reality is a more suitable and modern technology for effective learning in with traditional training programmes practising in Sri Lanka. Based on the survey result findings implementing VR based environment for university students has the potential to gain high-quality educational experience, team-spirited ability to enhance the leadership and soft skills need in the industries with high mental demand, performance to obtain a higher state of student performance. Comparing to traditional classroom learning programmes, students can involve in interactive live scenarios with a virtual study environment to build and increase their performance rather than an unrealistic traditional environment.

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