Virtual Reality for Learning: Assessment of Awareness and Preference in Emerging Regions

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Abstract— **In this research, the awareness and the preference of using Virtual Reality (VR) as a medium of Learning in the Emerging Regions in South Asia such as Sri Lanka, was assessed with a randomly selected audience of 250. Currently VR is one of the fastest growing industries globally and application of Virtual Reality in Education and Learning plays a significant role in its growth. Yet in emerging regions such as Sri Lanka, the uses of such technologies are relatively less. The experiment was conducted with 250 volunteers provided with a questionnaire before and after experiencing the Virtual Learning Environment (VLE). Historic scenery of Chola Dynasty was created with a Virtual tutor where the user was given the complete freedom to navigate in the historic scenery and learn from the virtual tutor. The scenery was designed and developed by considering Human Computer Interaction (HCI) heuristics, Hand-Gestures and realistic audio material in order to provide the learner a realistic and an immersive experience. The results showed that the majority of the school students show a major interest in using VR as a medium of learning and the second highest to show such an interest within the sample were the undergraduates. Even though the majority of the student and undergraduate community have not experienced VR before, this being their first encounter with a VR based application showed positive results. Also having various hand-gestures for the virtual characters used for tutoring showed to be very much effective as demonstrated by the results of the experiment.**

Keywords— **Virtual Reality, Virtual Learning Environment (VLE), Chola Dynasty**

I. INTRODUCTION

Virtual Reality (VR) is an extensively used technology in industries such as education, scientific simulation, tourism and entertainment [1][2]. Providing an immersive experience to the user has not only been attempted recently but ever since the 19th century. As stated in the records [3], since 19th century, various attempts such as 360-degree murals (or panoramic paintings) have been created to provide an illusion that the viewer is present in a different location. This could be considered as an early attempt of VR. Since then the advancement of VR accelerated and by 2017 the VR industry was valued at $14.1 billion according to Statista portal and it is predicted to be valued at $209 billion by 2022 [4][5].

Especially the applications of VR for education and training play a vital role in this massively growing industry. For example, as reported by Oculus VR [6][7], Walmart has invested in 17,000 Oculus Go VR headsets for employee training and to educate on customer service. Another major case study would be the US Army providing Microsoft with a $480 million contract to supply 100,000 HoloLens Augmented Reality headsets for training and combat purposes [8].

Moreover, before the introduction of 4G Network technology in 2010, major predictions were made on high quality video streaming as a benefit of the technology [9]. At present high quality video streaming has become a day to day service which is being used. Equivalent predictions are being made by the researchers for the introduction of 5G network technologies. It is expected to provide high speed and low cost internet which break barriers for VR applications. Hence it will also be opening new doors for Cloud based VR technologies [10].

Consequently studying the awareness and the preference on using VR for various domains has become increasingly important in order to design, develop and implement effective VR applications. The article by Harvard Business Review [11] supports as an evidence to highlight the significance of having market information when launching a product or service to a new market.

Considering the studies conducted using VR for learning, David et al [12] conducted an experiment involving a sample set of 19 students in United States. Based on the pre and post experiment questionnaires, participants reported a moderate level of presence in immersive VR in a scale of 1 to 7, [(M = 5.09, SD = 0.73), min = 3.56, max = 6.89]. In agreement with the study, the students who engaged in deep immersive experiences had gained higher knowledge and understanding about the climate changing application which was used in the study. As stated in the study made on using VR for Human Anatomy by S. Izard et al [13], the learners were able to get a realistic experience in practising anatomy. The ability not only to visualize but also to interact with the anatomy and having animations similar to the real anatomy had helped the users to understand and get educated on the subject area. In consonance with Tremayne et al [14], study on "Interactivity and Information Processing", yields evidence to support the fact that when the user interaction is high in the learning environment the learning effectiveness is also relatively high.

However a very limited number of studies have been done in emerging regions in South Asia similar to Sri Lanka with respect to VR based Learning. Majority of the studies have been done on e-learning methodologies and its' effectiveness which had focused on online and video based learning.

Referencing a few major studies that were carried on in the interactive learning domain, Weeraratne et al [15] researched to determine the effectiveness of using Khan Academy for learning in Sri Lanka and it has shown positive results. Based on the study, on average Khan Academy

resulted in increasing students' raw and scaled test scores by 3.77 and 3.15 percentage points, respectively, and standardized test scores by 0.20 standard deviations above the mean test score. Another study which was done in Sri Lanka for learning is a "Perception Enhanced Maritime Application" by Sandaruwan D. et al [16]. The application is a simulation of a reliable ship motion prediction system and perception enhanced immersive virtual environment with greater ecological validity. In consonance with the study, the experimental results had shown that the proposed framework is effective for learning, training and entertainment activities.

Yet Sri Lanka being an emerging country in the South Asian region a less number of studies has been conducted in analyzing the awareness and the preference for using VR as a medium for Learning and it remains a novel area of research within the area of Computer Science in Sri Lanka and similar demographics. Therefore without this knowledge creating effective VR related applications would be very much challenging [11] in the Sri Lanka and in similar demographics. Therefore a knowledge gap is clearly seen in this area which requires further study. Also discovery of such information could lead to taking effective and appropriate decisions when implementing VR based applications.

Therefore more than ever, it is necessary to study the awareness and preference of using VR applications.

Thus this research is to assess the awareness and the preference of using VR as a medium of learning in emerging regions in South Asia such as Sri Lanka and generalize to similar demographics. The historical Chola dynasty, which was one of the longest ruling dynasties was created in a VR scenery with a Virtual Tutor and was provided to 250 volunteers to explore and learn from the scenery. Data was collected from the volunteer group through a questionnaire both before and after experiencing the Virtual Learning Environment (VLE) in order to assess the awareness and the preference for using VR as a medium of learning.

II. Methodology

A. User Expectations

The design methodology was considered a high priority to build an immersive and a realistic historic VR scenery. Many users in Sri Lanka and in the South Asian region have been exposed to well designed mobile applications that consist of great User Interfaces (UI) and User Experience (UX). This is well evident from the annual social media report by Hootsuite 'We are Social' [17] for the year 2019. With respect to the report, the active social media usage in South Asia is accounted to be 24% while in Sri Lanka reported a penetration of 30% which accounts to 6.2 Million users. This implies that the chances of the users being exposed to quality video graphics, well designed UIs are relatively high, since most of the social media related interactions are well crafted in design. This also increases the user expectations from the interactive applications.

Fig. 1 The above image depicts the VLE of the historic Chola Dynasty. From the top historic Nataraja statue, God Shiva and the entrance of the VR scenery are shown respectively which are some of the scenes from the VLE. The user could navigate to any of these locations and learn about the historic value from the virtual tutor.

Consequently when designing the VR experiment it was vital to use user friendly design heuristics in order to avoid user dissatisfaction as a consequence of design in-capabilities. The experiment was specifically crafted with much consideration of various concepts and teaching cognitive techniques (hand gestures) to bring a fully immersive learning experience to the user. The design, development and the data collection was done in the following procedure.

B. Virtual Learning Environment (VLE)

To measure the effectiveness for learning when using Virtual Reality, a Historic lesson was chosen in this study. A historic location from the Chola Dynasty was created and the user was guided using arrows to visit various places in the scenery where a mystical tour guide would tutor the user explaining the location. The user was given the freedom to navigate throughout the historic location in the VLE exploring the space by him or her.

The VLE was designed using Unity Video game engine 2018 version and, asset materials from the Unity asset store were used in creating the scenery. To create realistic characters and animations Adobe Mixamo was used. Figure 1 depicts the Computer generated Historic scenes and Figure 2 depicts the computer generated Virtual tour guide from the VLE.

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Fig. 2 The interactive historic tour guide of the VR scenery

C. Heuristics of Human Computer Interaction

When creating the VLE, the objective was to give the user an immersive and a realistic experience where he or she could also navigate through the scenery effortlessly. In order to provide a better UX the system was designed by considering the Usability Heuristics by Nielsen J. [18] and integrating them for VR. When it comes to VR, the user-interface becomes the entire VLE (visual) for the user. Therefore the heuristic principles of Niels J. were mapped to the VR User Interface as follows.

For humans the comfortable range of vision would be 0.5meters to 20meters in-front [22]. Anything which is too close to the viewer will make him or her cross-eyed and anything which is further may tend to blur the element. Therefore interactive elements and special guidance information were placed within the above mentioned range of sight to provide a better user experience for the learner.

Also when placing such interactive elements, placement was done by considering the Human eye comfort zone which is a 60 degree [22] limit. Most of the 'call to action' elements were placed in the eye comfort region while any other required interactive elements were decided to be placed on the neck comfort zone which has a 120 degree limit [22]. According to the heuristics by Jakob Neilsen [18], the interface should provide clearly marked functions where the user could make his actions without making any mistakes. That is 'User Control and Freedom & Recognition than recall'. At a point of a mistake the user should be able to undo or redo its actions.

This concept was integrated to:

- The users movement/navigation
- The historic location/artefact identification
- The 'Call to Action' objects identification

In order to cater to the above requirement, the orientation of the mobile device was used. Since the mobile device was connected (plugged) to the VR headset the orientation of the device was able to be mapped to the rotation of the head which provided a realistic experience to the user to navigate in the scenery by looking down to walk and turn naturally to explore the scenery.

Throughout the historic scenery, two types of arrows were displayed for the user to easily navigate the scenery. First, arrows horizontal to the ground as shown in Figure 3 which were used to guide the user to visit key locations on the scenery. These were used as road directions to visit prominent places in the scenery. At any point when the user gets lost in the VLE, the user could easily get back by following the arrows.

Fig. 3 Horizontal Directional Arrows which guides the user to navigate to key locations in the VLE. These arrows were given a rotational animation along its horizontal axis to depict the direction that the user should navigate to.

The second types of arrows were landmark arrows which were placed vertically near special historic artefacts as shown in Figure 4. When the user is nearby the location and gaze at the arrow, the tour guide would explain the artefact. The user should be in the field of view mentioned in the above section when looking at the arrow to enable the explanation. At the beginning of the VR scenery the tour guide will brief about the key elements that the user will come across in the scenery and how the user could interact with them.

When considering the assets and environment for the VLE, the use of high polygonal model assets were used consistently whenever possible over the selection of low polygonal models. Maintaining such consistency throughout the scenery without exploiting the performance of the device, a realistic and an immersive experience was able to provide to the user.

Fig. 4 Vertical arrow along with the computer generated tour guide. At major historic locations within the VLE vertical arrows were placed to assist the learner to identify the hot spots at a distance. The vertical arrows were animated along their vertical axis to highlight them among the other stationary virtual objects in the VLE.

D. Tutor Hand-Gestures

Numerous studies have shown that hand gestures have a considerable impact on the effectiveness on tutoring [19][20]. When designing the virtual tutor we included hand gesture animations to the tutor as shown in the Figure 5, which would portray convincing of a point, openness and the scale of a topic being discussed [21].

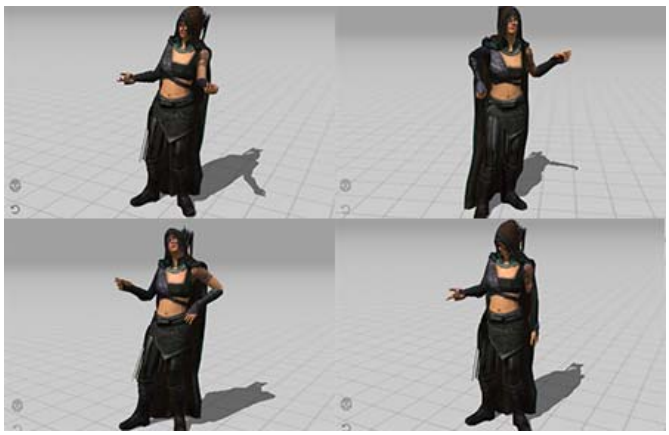

Fig. 5 Hand Gesture movement of the Virtual Tutor. Explaining a fact [Top-left], convincing a point [Top-right], gestures on Confusion [Bottom-left] and uncertainty of a point and counting [Bottom-right].

E. Realistic Voice and Sounds

In order to provide the virtual tutor an expressive and a natural outlook we used human recorded audio clips for its voice. Consequently bringing much more realistic expression to the learner.

Another important factor when providing an immersive experience in VR is the realistic sound effects [24]. When creating the VLE, audio sources and audio settings of the VLE play a major role throughout the scenery in order to give an immersive and a realistic experience to the user. Therefore the natural sounds which were in the VLE were synchronized with the distance of the current position of the user. Also to make the audio experience more realistic, we use spatial sounds [25]. It gave the sense to the user as the sound propagates from a specific direction.

In the scenery we used numerous natural sounds such as blowing of wind, ringing of bells in the temple, chirping of birds, burning of fire in the fire pots and etc. The use of the spatial sounds for the above instances made the VLE more natural and realistic since it denoted a specific direction of sound propagation.

The synchronization of the sound with the distance of the user was used to experience the realistic feeling of the increase and decrease of the sound while navigating in the historical location. As the user moving near an audio source the sound will increase and also when moving away from the audio source the sound will decrease. For instance, in the scenery fire pots were used alongside the path of the navigation. If the user moves near the fire pot the sound of the burning fire will increase as it is near the user. When the user is moving away from the fire pot the sound will decrease according to the distance of the user. Similar sources of sound were used in the scenery which assisted in creating a realistic VLE. In order to create variation of volume with the distance from the sound source, custom roll off curves facility and 3D sound settings were used from the Unity development tool. The roll-off curve was implemented using a logarithmic decay function as follows.

The Figure 6 depicts the roll-off function curve created for a single sound source. Until the distance from the sound source reaches the minimum distance (min.dist) the volume level will remain constant while it will gradually decay afterwards. When distance reaches and exceeds the maximum distance (max.dist) the sound source will be muted.

The section wise development of the function f(x) is depicted in the equation 1 where x denotes the distance from the sound source varying in 3 different sections based on the minimum distance (min.dist) and maximum distance (max.dist). The function g(x) shown in equation 2, represents the decaying portion of the roll-off curve where λ is a arbitrary positive real value.

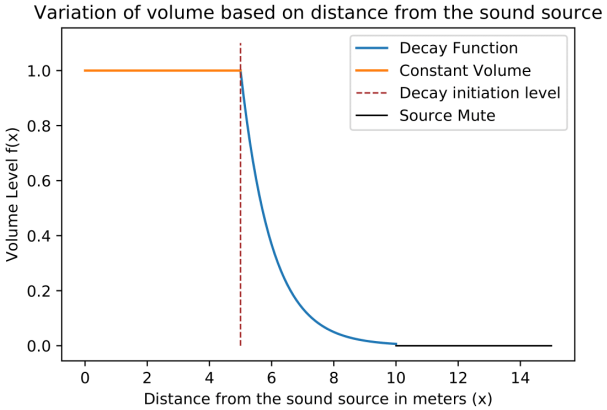

Fig. 6 Roll-off graph of distance from the sound source vs the volume level. As the distance from the sound source increases up to 5 meters (min.dist) the volume level will remain constant while it will gradually decay afterwards until the distance reaches 10 meters (max.dist). After the 10 meter radius from the sound source the volume will be muted. The volume level 1.0 represents the original wave form provided in the audio file.

$$f(x)\begin{cases}1 & 0 \le x \le min.dist \\ g(x) & min.dist < x < max.dist \\ 0 & max.dist \le x\end{cases} \quad (1)$$

$$g(x) = e^{-\lambda(x-min.dist)} \quad (2)$$

F. Development

For the development of the system Unity video game engine version 2018 was used along with the Google VR SDK for virtual environment creation. For asset acquisition Adobe Mixamo and Unity asset store was used. The scenery was compiled and the APK file was installed on two android phones. A Huawei Nova 3i device and a Samsung S10 device was used along with two VR boxes. A general purpose audio headset was used which was connected to the mobile device.

G. Questionnaire and Data Collection

The experiment was conducted in a classroom familiar environment where it was limited with space and subjected to random noises. The user was provided with the devices mentioned in the section II F in order to interactively engage with the VLE. The sample consisted of 250 random volunteers from Sri Lanka. The sample was aged between 5 and 50 years with the ranges of age values as 5 – 10 years, 11 - 15 years, 16 - 24 years, 25 – 45 year and 46 years and above. The sample contained school students, Undergraduates and Employees with a composition who had (33%) and had not (67%) previously experienced VR. The volunteers were provided with an online questionnaire before and after experiencing the VLE. Each user was provided with a time-period of 20 minutes to engage with the VLE. The questionnaire was designed to capture the awareness and the preference of using VR as a medium of

learning in different segments of the selected demography and the affect on the barriers of VR adaption [26][27].

Initially the pre-experiment questionnaire was given. The questionnaire contained the following questions.

1. Age
2. Occupation
3. Awareness about VR (Yes, No, A little)
4. Previous experience with VR (Yes, No)

After 20 minutes of engagement in the VLE the post-experiment questionnaire was provided which contained the following questions.

1. Did wearing a VR Box make the experience uncomfortable to you? (Yes, No, A little)
2. Did you notice any hand gestures of the human figure shown in the VR? (Yes, No, A little)
3. Did the hand gestures help you understand the story more? (Scale from 1-5 being the most)
4. Were you guided enough to walk inside the building? (Scale from 1-5 being the most)
5. Do you think Virtual Reality is a good medium for teaching? (Scale from 1-5 being the most)
6. Rate your experience as a whole (Scale from 1-5 being the most)

The pre and post experimental data was combined together before the statistical analysis was done. Figure 7 is a capture from the moment of the experiment.

The objective of the pre-experiment questionnaire was to measure the awareness of VR technologies in the selected demography and to compare their feedback after using the VR platform. Specifically, the first time users feedback on the VR technologies and the factors affecting the preference of the demography was required to be identified through the post-experiment questionnaire.

Fig. 7 Volunteer taking part in the experiment

III. Results

The data was evaluated to gather the results for the awareness and the preference of using VR as a medium of learning in the selected demography. The results were obtained by analyzing the data collected via the two questionnaires provided to the volunteers who experienced the VLE for equal time duration. The questionnaires were provided before and after experiencing the VLE. All the participants were Sri Lankans. 250 volunteers participated and filled the pre-experiment questionnaire while only 164 volunteers filled and submitted the post-experiment questionnaire. The latter 164 data entries were mapped with the pre-experiment data entries for further analysis.

A. *Awareness on VR Technologies*

The Table I depict the general awareness composition of the selected 250 volunteers who submitted for the pre-experiment questionnaire. The gathered data was subjected to Pearson's Chi-squared test afterwards. As per the analysis it is seen that the age of a person has a statistically significant impact on the awareness of VR technologies (X2 = 20.164, df = 6, p-value = 0.00259). The age group that shows the highest percentage (87.5%) of participants who have 'at least heard' (Response of 'A little' and 'Yes' together) VR technologies, is 16 – 24 years. Participants from the age group 5 – 10 years are the ones with the least awareness percentage of 25%. This depicts that the youth is aware of VR much more than small children and other age groups which is an important fact to be considered especially when introducing VR based products to markets of this caliber.

TABLE I
AGE VS RESPONSE FOR THE AWARENESS ON VR OUT OF 250 VOLUNTEERS ALONG WITH THE RESPECTIVE PERCENTAGE VALUES.

	Response			
Age range	**Not at all**	**A little**	**Yes**	**Total**
5 - 10 Year	6 75%	1 12.50%	1 12.50%	8 100%
11 – 15 Years	25 52.08%	13 27.08%	10 20.83%	48 100%
16 – 24 Year	20 12.50%	66 41.25%	74 46.25%	160 100%
25 – 45 Years	6 17.65%	8 23.53%	20 12.50%	34 100%
Total	**88 35.20%**	**88 35.20%**	**105 42.00%**	**250 100%**

B. *Learning Preference Using VR*

Out of the 250 volunteers who participated only 164 volunteers submitted the post-experiment questionnaire. Pearson's Chi-squared test was conducted on the data set of the 164 volunteers to measure any statistical significance on the following.

1) Age vs Preference: There was insufficient evidence to reject the null hypothesis that preference of a participant on using VR as a teaching methodology, by his/her age at the 5% significance level. (X-squared = 19.55, df = 12, p-value = 0.07609)

2) Employment Status vs Preference: The impact on ones opinion about suggesting VR as an effective teaching methodology, by his/her employment status. According to the analysis there is a statistically significant impact on ones opinion about suggesting VR as an effective teaching methodology, by his/her employment status. The null hypothesis was rejected at 5% level of significance. (X-squared = 18.993, df = 8, p-value = 0.01489). As it is clear from the descriptive statistics given in Table II the highest percentage (72%) of participants who have rated 5 (highest)

to suggest VR as an effective teaching methodology, were school students.

TABLE II
EMPLOYMENT STATUS VS THE RESPONSE ON PREFERENCE ON USING VR FOR LEARNING ON A SCALE OF 1 TO 5 (BEST) OUT OF 164 VOLUNTEERS WHO PARTICPATED AND RESPECTIVE PERCENTAGE VALUES

	Occupation			
Response	**Employed**	**Schl. Student**	**Undergraduate**	**Total**
1 (Least)	0 0.0%	3 3.6%	2 3.1%	5 3.0%
2	0 0.0%	1 1.2%	3 4.7%	4 2.4%
3	3 16.6%	4 4.82%	10 15.8%	17 10.3%
4	7 38.8%	15 18.0%	21 33.3%	43 26.2%
5 (Most)	8 44.4%	60 72.2%	27 42.8%	85 57.9%
Total	**18 100%**	**83 100%**	**63 100%**	**164 100%**

3) Hand Gestures vs Preference: The hand gestures made by the virtual tutor were evaluated. According to the results gathered there was insufficient evidence to reject the null hypothesis on the dependency of the preference of suggesting VR as a teaching methodology to the effect of noticing any hand gestures by the VR tutor in the VLE. (X-squared = 5.3886, df = 8, p-value = 0.7154)

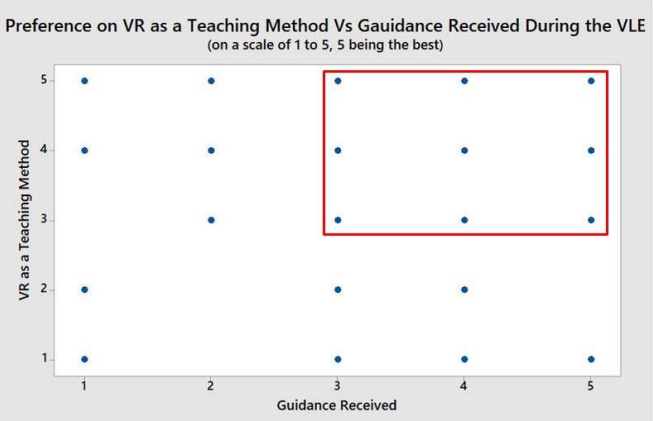

Fig. 8 The independent and the dependant axis represents the rating received from 1 to 5 (Best). The area marked in the figure depicts the majority of the participants who have rated 3 or above for the guidance received in the VLE, have also rated 3 or above for their preference of suggesting VR as an effective teaching methodology.

4) Guidance Provided vs Preference: The guidance provided relates to the convenience in understanding the VR scenery with instructions to navigate and learn in the VLE. The null hypothesis was rejected at 5% level of significance and it was proved that there is a statistically significant effect on the preference of suggesting VR as an effective teaching methodology by the amount of guidance him/her received while virtually going through the path. (X-squared = 66.373, df = 16, p-value = 4.27e-08). As seen in the Figure 8 majority of the participants who have rated 3 or above for the guidance received, have also rated 3 or above for their preference of suggesting VR as an effective teaching methodology.

C. Overall Experience

1) Preference vs Overall Experience: According to the analysis out of the Pearson's Chi-squared test, it was proved that there is a statistically significant effect on the overall VR experience by the preference to VR being used as a teaching methodology, at a 5% level of significance. (X-squared = 157.34, df = 16, p-value (<) 2.2e-16). It is clearly seen in Figure 9 that almost all who rated 3 or above for the learning preference have rated 3 or above for the overall experience.

2) Hand Gestures vs Overall Experience: According to the results obtained from the Fisher's Exact test, it was proven that there exists a statistically significant effect on the overall experience of a participant by the amount of hand gestures him/her has noticed. (p-value = 0.01734,Fisher's Exact Test)

3) Guidance Provided vs Overall Experience: According to the results obtained from the T test, the null hypothesis was rejected at 5\% level of significance.(t(305) = -4.41, p = 0.00) Consequently it is proved that there is a statistically significant relationship between the overall experience and the guidance provided within the VLE.

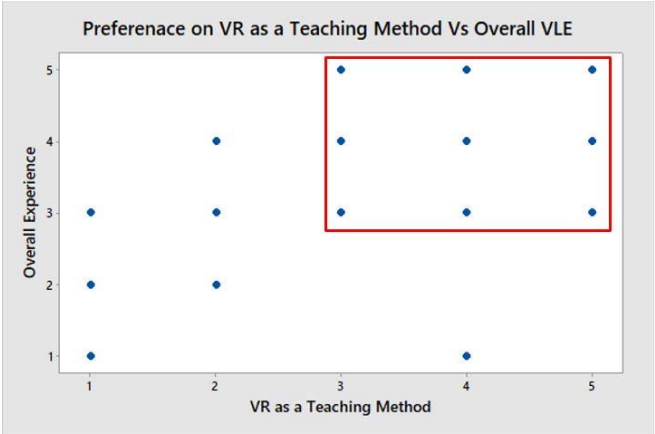

Fig. 9 The independent and the dependant axis represents the rating received from 1 to 5 (Best). The area bounded depicts that the majority who rated 3 or above for the preference of using VR as a learning medium have rated 3 or above for the overall experience in the VLE.

IV. DISCUSSION

The experimental results of the study demonstrate the awareness and the preference of using VR as a medium for learning in Sri Lanka and similar demographics in emerging regions in South Asia. The experiment was conducted with 250 volunteers provided with a questionnaire before and after experiencing the VLE. The VLE consisted scenery of a historic Chola dynasty with a virtual tutor, where the user was given the full freedom to navigate the VLE and learn from the virtual tutor. The scenery was designed by considering various HCI heuristics, hand gestures and realistic audio material in order to provide an immersive and a realistic experience to the learner.

This study is one of the first researches to assess the awareness and the preference of using VR as a medium of learning in Sri Lanka and it has been a major success.

The findings of the research demonstrate that age groups between 11-15 years and 16-24 years (highest 87.5%) are

very much aware about VR technologies but the majority has not been exposed to using VR technologies as proved in the Table I. The relatively high awareness rate could be clarified with an indirect source of reference, since similar studies have not yet been conducted in Sri Lanka. According to the social media statistics survey – 2018 [23], 41% of the social media users in Sri Lanka are accounted to be in the age range of 18-24 and 50% accounts to the age category of 25-35 age range. The probability of the latter age group surfing for technological trends could be relatively less based on their interest levels. This supports as evidence for the reason that there is a high awareness in the age group of 18-24 towards VR technologies. Likewise this age category represents a mixture of both the school as well as the undergraduate community who are more likely to search more on technological trends.

However when the data was analysed for the age and the preference of having VR for learning, the evidence was not adequate to reject the null hypothesis. But the null hypothesis for the employment status and for the preference of having VR learning was rejected with a significance level of 5%. That is 72% of the volunteers who marked the rating of 5 are accounted to be school students as proven in the Table II. The distribution of the preference rating of the school student category (category of highest preference) is shown in the Figure 10. This clearly demonstrates that there is very high preference among the school students to use VR as a medium of learning. Yet this information was not visible in the Age vs Preference analysis and consequently it suggests for further study in the area. A likely reason for not being able to witness the above mentioned dependency would be due to the selection of age categories overlapping with school and undergraduate age groups.

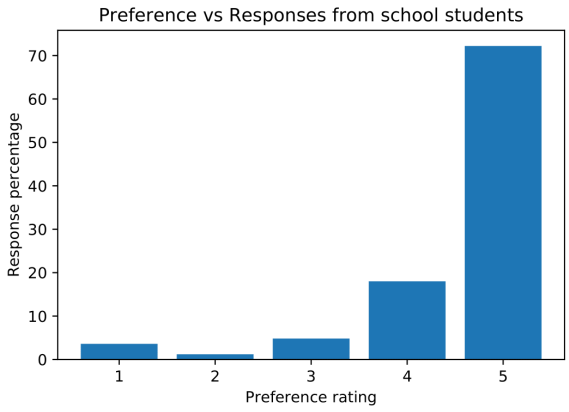

Fig. 10 The independent variable axis represents the rating received from 1 to 5 (Best).The distribution of the preference ratings for using VR as a medium of learning from the school student category where 72% accounts for rating 5.

Various studies have proved the effectiveness in using hand-gestures when tutoring, in presentations and in speech [19][20][21]. The data indicated in the analysis failed to reject the null hypothesis for the dependency among the preference of suggesting VR as a teaching methodology and the effect of noticing any hand gestures by the VR tutor in the VLE. However the null hypothesis was rejected by a significance value of 5% when compared with the overall experience of a participant by the amount of hand gestures him/her has noticed.

This clearly demonstrates that there is an effect on the overall experience but not in the learning experience which builds up a clear requirement of deeper study in this area to measure the effectiveness of hand gestures in a VLE.

The VLE was designed considering HCI heuristics [18] to make sure that the user understands the environment effortlessly. It was proved that the effect on the preference of suggesting VR as an effective teaching methodology and the overall experience in the VLE is dependent on the amount of guidance him/her received while navigating through the VLE. Consequently it was understood, when designing a VLE it is very much important to provide assistance and guidance for the user to navigate in VLE to achieve higher effectiveness. Finally it was proved that the effect on the overall VR experience has an impact from the preference rating of having VR as a Learning medium. This clearly demonstrates that the volunteers who preferred to have VR as a learning medium have also experienced an overall high quality of VR experience.

V. CONCLUSION AND FUTURE WORK

The VLE was designed and developed with the objective of assessing the awareness and the preference for using Virtual Reality as a medium of Learning in Sri Lanka and similar South Asia countries. The experiment demonstrated that the age group of 16-24 has the highest awareness of (87.2%) while the second highest was proven to be the 11-15 (47.9%) age group. Yet the other age categories have indicated a very low amount of awareness with regard to the VR technologies. The experiment also demonstrated that the school students possess a higher preference (above 72%) for using VR as a medium of learning yet no dependency was found between age and preference of using VR as a medium of learning. It was also proven that providing virtual assistance in the VLE and use of various usability principles has a positive impact on selecting VR for learning and its overall VR experience. The experiment also indicated that the usage of various hand-gestures by the Virtual tutor has made a positive impact on the overall experience for the Learner in the VLE. Therefore these statistics can be considered as a general approximation to acquire an initial understanding about the awareness and the preference of using Virtual Reality for learning in the South Asian regions.

Further study on the impact of using hand-gestures for virtual tutors in VLE and the preference of VR as a learning medium with respect to age groups using a different age range is required.

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