VIRTUAL REALITY INSTRUCTIONAL TECHNOLOGY IN A HIGHSCHOOL LEARNING ENVIRONMENT: A QUALITATIVE STUDY

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Abstract: A primary challenge that high school instructors face is finding learning technologies to educate their students without the learning curve and use of the technology presenting additional barriers to the students' learning experience. Many high school aged students are already familiar with virtual reality (VR) technology in the gaming industry. Some high school instructors use VR to help their students learn. This study was a qualitative, descriptive, phenomenological study. Study results provide high school staffs with recommendations on improving academic performance as well as the learning experience. The theoretical framework chosen was Technology Acceptance Model (TAM) to reflect end-user feedback.

IndexTerms - **virtual reality technology, high school learning environment, virtual classroom.**

I. INTRODUCTION

High school instructors and administrators have a goal of using contemporary technology to improve the academic performance of their students. Instructors would like to use technology that encourages the students to be proactive about their academic studies. The use of virtual reality (VR) technology is a very common aspect of the contemporary technological landscape in many industries around the world. Virtual reality technology is particularly entrenched in the gaming industry and is in widespread use among many high school aged students around the world. High school teachers and administrators are beginning to use the technology with the goal of improving the high school learning experience. Since many high school aged students already use VR technology in their everyday lives, some of their instructors feel that such use would also reinforce their educational goals, especially, if VR technology can be efficiently implemented into the high school learning environment.

Another school of thought is if the students are having fun as they learn they will be more proactive in regard to their academic studies. The term edutainment is used to describe the merging of entertainment and education. Instructors at every level of education, secondary and post-secondary, have understood that students need some degree of hands-on learning in order for them to fully grasp the desired academic concepts. Virtual reality technology provides the ability to expand on resources that computer-related technology, like the Internet, provides students (Gaudiosi, 2016). Virtual reality technology offers students the ability to view a learning environment from a virtual three-dimensional environment (Reede & Bailiff, 2016). For example, this would allow them to get a better understanding of historical events, such as the signing of the Declaration of Independence, or scientific experiments like seeing how the human nervous system works.

As is typical with most new, and/or advanced technologies in corporate America, including VR, academic institutions are generally slow to implement such technologies into their curriculum. The reluctance to implement the new technologies being used in corporate America into academic America is due to a number of factors, such as cost, availability, lack of instructor expertise with the technology, and incompatibility with current technological infrastructure, etc. Many post-secondary and secondary schools will wait to see if the advanced new technology will have some kind of staying power in the industry. Sometimes the new technology is advertised with much fanfare only to be superseded by a competing technology. In the mid-2000's for instance, the social media website MySpace was the primary social media website on the Internet. However, just a few years later, the popularity of Facebook usurped the market share of MySpace. Going further back, in the early 1980's the video cassette recorder (VCR) market was comprised primarily of the Betamax (Beta) and VHS tape devices. When the film industry began adopting the VHS format, Beta was essentially phased out. The trajectory of VR technology has not been without its own competitors and similar challenges giving pause to some high school administrators over whether or not to implement VR technology as a learning tool, and if so, which VR technology to use, (Gaudiosi, 2016).

While the use of VR technology is becoming more and more widespread in a myriad of industries, implementation of VR into the academic environment has been met with some of the same challenges insofar as dealing with cost, availability, and lack of instructor expertise with the VR technology, etc., (Reede & Bailiff, 2016). These Advancements in VR technology are being pursued by major multinational firms like Microsoft, Apple, IBM, Google, and several others. However, VR technology pioneering predates the current gaming industry and even predates the rise of the video game arcade era of the 1990s, (Jensen, 2016).

The focus of this study derives from the need of high school instructors to find the proper balance between using technology to broaden their students' educational outlook, while helping to foster a more conducive academic solution that is reinforced by their students' extra-curricular activities. The reason the focus of this study is on high school students rather than middle or elementary school students is because the attrition rate for high school students is much higher than that of students in earlier levels of education. This study also looks at whether or not VR technology implementation in a high school learning environment can be used to help students learn while simultaneously drawing from student familiarization with similar technologies used in their everyday life.

One of the issues that we encountered in researching VR Technology was the potential technological and/or historical bias that might be programmed into technology. Much of our perceptions of historical events come largely from what we see in popular culture such as, movies, television, videos, books, and magazines. If these technologies have failed to give high school students a firm grasps on the educational foundations of history, we would have to research how VR technology would be different. The use of VR technology may not help the intended end-user students if it only visually regurgitates popular misconceptions, such as "Abraham Lincoln freed the slaves." or "Christopher Columbus discovered America". Our literature review goes over the research information that we found on the historical use of VR technology and its varying uses in the academic, as well as, the professional industries.

II. LITERATURE REVIEW

Previous studies and research have focused on academic institutions, as well as the corporate world. Most of the current research on the subject focuses on the academic use of VR technology in a general sense regarding all students from kindergarten through high school. This study will center on how VR technology solutions can be implemented in order to improve scholastic achievement at the high school level.

There is a great deal of literature discussing a myriad of uses for virtual reality technology in numerous fields. The computer-generated simulations of virtual reality technology have been used over the years to train pilots in both the military and commercial flight industries. The film industry has been using VR technology for several years attempting to enhance the viewing experience of the audience. Virtual reality technology is even being used in the medical industry to simulate surgical procedures for medical students (Haluck & Crummel, 2000). NASA is using VR technology to simulate extra-terrestrial exploration (Szoldra, 2016). The US Air Force is using VR technology, not only to train pilots, but also to fight wars on foreign soil remotely. The US Army is now using VR technology to train soldiers for battle in an effort to reduce injuries during live training, as well as to reduce the associated costs of training personnel, travel and equipment (Kipper & Rapolla, 2012). However, the genesis of VR technology advancement comes primarily from the gaming industry.

In 1968, Ivan Sutherland, a Harvard University electrical engineering professor, created the first modern VR technology device called "The Sword of Damocles", (Bagrov, 2016). It was a pioneering type of display which utilized a head-mounted binocular system. Sutherland's device, "The Sword of Damocles", was a loose allusion to the Greek anecdote about Damocles, because it was so heavy that it had to be mounted.

VR Technology has progressed quite a bit from the time that Sutherland created "The Sword of Damocles". This technology has evolved as a tool that can be of use for several different professional and educational fields. From the academic side, much of the literature on virtual technology is either broad-based and focuses on all levels of secondary education (K-12), as well as in post-secondary schools. However, in professional fields VR is also used in research. There is not a great deal of literature that focuses directly on the high school experience of using VR technology.

We found one study where VR technology was used to teach students about the Harlem Renaissance (Sonoski, Harkin, & Carter, 2006). The technology provided students with an opportunity to see people, places, and the cultures of the Harlem Renaissance by recreating them in a simulated environment. The VR technology also covers the historical eras of United States chattel slavery and the Jim Crow laws that preceded the Harlem Renaissance.

Researchers are using virtual reality for studies in the area of paleontology (Griffiths & Beal, 2016). The VR technology used in the field of paleontology is a photographic technology that can calculate what preserved objects like bones will look like based on where they are found and what position they are in when found. The technology uses Tomography for three-dimensional structure analysis. This information can help allow paleontology researchers to determine which artifacts would be most important for further research and which artifacts may not be worth much additional investigation. Virtual reality technology was used to allow learners to explore the city of Paris, France, with the study also discussing the evolution of technology from stereoscopy to VR technology as it shows how the city looked from various times throughout the period of 1850 – 2000 (Reynaud, Tambrun, Timby, & Carnavalet, 2000). This includes not only the beautiful scenery and artwork, but also impact that World War I and World War II had on the city.

Many high school aged students are already using similar technologies for gaming purposes in their extracurricular activities. Similar technology, concepts, and practices could be used to help high school aged students learn and expound on academic concepts. Our research study seeks to bridge the gaps between what many students are already doing with VR technology with what many teachers would like to help students accomplish academically.

Research question. In what ways, if at all, can high school instructors use virtual reality technology to increase the value of the overall learning experience of high school aged students?

We chose this research question because it is comprehensive enough to solicit information that will unambiguously give us feedback on how to help teachers and school administrators with the task of assisting their students to with attaining their academic goals. The study is designed to help high school students, as well high school teachers. By focusing more directly on how VR technology can assist high school students, we hope this study can start a more focused dialogue on that topic.

III. METHOD

Participants

The participants in this study were chosen due to having some teaching experience with high school aged students. The information was collected from high school instructors working in the north central area of Texas. There were 10 participants in the study and each one of the 10 participants completed the questionnaire. A total of 10 participant-respondents were selected, which is consistent with the recommended number of respondents to achieve saturation for this type of study, (Mason, 2010). Creswell (1998) states that 5 to 25 users is a sufficient sample size for a phenomenological study. The study objective was explained to the participants.

Materials

A survey questionnaire was used. The questions in the survey questionnaire were a combination of Likert-scale, and open-ended questions with one question requiring both a likert-scale and open-ended answer for the sake of triangulating the data.

Procedure

The purpose of the study was explained to the prospective participants. The names of the participants were coded randomly and alphabetically from A to J. Questions 1-3 were Likert-scale questions. Questions 4-6 were open-ended questions. Question 7 was a combination of both requiring Likert-scale and open-ended responses. The purpose of this qualitative, phenomenological research study is to evaluate the effectiveness of high school instructors in the implementation of VR technology in a high school learning environment for the purpose of improving the overall learning experience for their students. The qualitative, phenomenological approach was best suited for this research due to the main focal point of the study being about the feelings, opinions, and general feedback from instructors who work with high school aged students. This study is intended to get an understanding of how end-users feel about using VR technology in a high school setting. The theoretical framework chosen was the Technology Acceptance Model (TAM). The TAM was selected to illustrate how end-users are impacted with the implementation of changes to technology in their working environments. A quantitative study would not be best suited for this research study because this study was not concerned with information such as raw data in the form of how many schools were using VR technology or how many students were playing VR technology video games. For this study we wanted to find out why teachers felt that VR technology could help their students.

Instrumentation

The survey questionnaire was deemed valid for this study. The survey questionnaire asked the Likert-scale and direct open-ended questions of study participants in an attempt to answer the research question of the study. The survey questionnaire was specifically aimed at determining whether or not the participants felt the implementation of VR technology would help their students learn in an academic setting. There were no significant biases to affect the study. The instrument is attached in this study in the Appendix as Table 2.

IV. RESULTS

The results of our study showed that all of the participants in the study felt that VR technology could help them in teaching academic concepts to their students (8 participants strongly agreed, and 2 participants agreed). A small majority of the participants felt that school management would support the implementation of VR technology into their schools (3 participants strongly agreed, 3 participants agreed, 1 was neutral, 2 disagreed, and 1 strongly disagreed). A large majority of the participants believed that VR technology would be financially feasible to implement at their schools (5 strongly agreed, 3 agreed, 1 was neutral, and 1 disagreed). Only a small minority of the participants felt that their students having previous or alternate access to other VR technologies would give them an advantage over other students in an academic setting (2 strongly agreed, 2 agreed, 1 was neutral, 4 disagreed, and 1 strongly disagreed).

Under the open-ended questions, most felt that VR technology would be most helpful in the subjects of history, and sciences like geography and biology. Participant B stated that this was because VR technology gave a visual representation thus easing comprehension of sometimes difficult to understand concepts. A majority of the participants in the study felt that VR technology would not be helpful with mathematics. Participant H stated that this was because teachers already had the capability to demonstrate mathematical calculations and the visual representation was not at the core of the inability to learn mathematical equations. A majority of the participants in the study felt that using VR technology for lab and study assignments was the best use of VR implementation. Refer to the Appendix Table 1 for the responses to the Likert-scaled questions. See the Appendix Table 2 for the full survey questionnaire.

V. DISCUSSION

The focus of our research was to discover in what ways, if at all, could high school instructors use virtual reality technology to increase the value of the overall learning experience of high school aged students. It was our hypothesis that VR technology could be used to increase the overall learning experience of high school aged students. We focused on high school aged students because their academic attrition rates are much higher than those at middle and elementary school levels. The study validated our hypothesis, but for some different reasons than we had anticipated. Only 50% of the participants in the study believed that that the high school students' exposure to current extra-curricular VR technology would influence the academic learning environment for them. We felt that this was a very low number considering the number of participants who indicated that they would be favorable to the implementation of VR technology as tools for facilitating their course curriculums. What we learned from the study was that the reason for this seemingly low level of confidence in high school students using their

familiarization with VR technology to help them with similar technology in an academic environment was surprising. Namely, that in the participants' experiences, many high school aged students already had exposure to technologies like computers, Internet, and mobile reading devices that they were familiar with, however the overall grades of these students had, for the most part, remained unchanged during the tenure of their teachers.

What we found through the study was that while technology changes rapidly, human nature does not. Those students who are motivated and want to avail themselves of on hand technological tools to attain high academic marks will tend to do so, and those who are, for some reason, not as motivated will not do so. Our contemporary technology is at a point where we can communicate with just about anyone on the planet from just about anywhere on the planet. We have access to vast amounts of data that previous generations may not have thought possible. However, academically, many students still struggle even though so many technological tools are available.

The existing literature discusses how VR technology is being used in a number of professional fields and academic disciplines. Microsoft is leading in VR technology industry with research and development in the professional and gaming industries, (Mack, 2016). Apple is working with Stanford University to develop a VR technology that can more efficiently train new employees in the workplace, (Painter, 2016). In the professional fields, the individuals that are pioneering VR technology are highly motivated in developing their craft. This stands in contrast to many in the gaming industry who are only using VR technology for entertainment. One limitation that we had not accounted for is human nature.

The implications here are that students who were not motivated to use televisions, computers, or the Internet for educational purposes are likely to be the same types of students, or those with similar personalities who will not use VR technology for academic purposes outside of the academic environments even if they are required to use them. While the consensus is that VR technology would certainly help high school students by enhancing the academic learning environment, teachers will still need to be vigilant and trying to reach the students on a personable level. The parents of the students will need to help foster a home environment that also reinforces the academic learning environment.

Future related studies could cover research into human motivational factors regarding the use of technology. When the social and financial limitations to access of technological resources are removed, are there still remaining barriers to the use of technology as a tool for academic and personal enhancement? Further studies could delve into such limitations whether proven or theoretical.

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APPENDIX
Table 1

Likert-scaled Participant Questions and Responses
Question #1

Do you believe that Virtual Reality technology would be helpful to you in teaching academic concepts to your students?
8-Strongly Agree 2-Agree 0-Neutral   0-Disagree   0-Strongly Disagree

Question #2

Do you believe that your school's executive/administrative staff would be in support of implementing Virtual Reality technology?

3-Strongly Agree 3-Agree 1-Neutral   2-Disagree   1-Strongly Disagree

Question #3

Do you believe that Virtual Reality technology would be financially feasible to implement at your school?

5-Strongly Agree 3-Agree 1-Neutral   1-Disagree   0-Strongly Disagree

Question #7

Do you feel that students already having access to Virtual Reality technology in form of gaming technology in their extra-curricular activities will have an advantage when using Virtual Reality technology for academic purposes? Please expound on your answer

2-Strongly Agree 2-Agree 2-Neutral   3-Disagree   1-Strongly Disagree

Table 2
Study Participant Full Questionnaire

Participant Name (Code) _____
Question #1
Do you believe that Virtual Reality technology would be helpful to you in teaching academic concepts to your students?
O Strongly Agree O Agree O Neutral   O Disagree   O Strongly Disagree

Question #2
Do you believe that your school's executive/administrative staff would be in support of implementing Virtual Reality technology?
O Strongly Agree O Agree O Neutral   O Disagree   O Strongly Disagree

Question #3
Do you believe that Virtual Reality technology would be financially feasible to implement at your school?
O Strongly Agree O Agree O Neutral   O Disagree   O Strongly Disagree

Question #4
Which subjects do you believe would your students would most benefit from using Virtual Reality technology and why do you feel that way?

Question #5

Which subjects do you believe would your students would least benefit from using Virtual Reality technology and why do you feel that way?

Question #6

In what ways, if at all, can high school instructors use virtual reality technology to increase the value of the overall learning experience of high school aged students?

Question #7

Do you feel that students already having access to Virtual Reality technology in form of gaming technology in their extra-curricular activities will help them with their academic use of Virtual Reality technology? Please expound on your answer

O Strongly Agree O Agree O Neutral   O Disagree   O Strongly Disagree