ADOPTION OF VIRTUAL REALITY IN LEARNING AMONG HBCU STUDENTS

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ABSTRACT

As the benefits of virtual reality are increasingly apparent, its adoption in learning is rapidly increasing. The study investigates HBCU students' intention to adopt virtual reality technology in their learning with the Technology Acceptance Model framework. The results show that entertainment characteristics of virtual reality has the strongest influence on all of the constructs (ease of use, perceived usefulness, and intention) in the research model. However, ease of use and perceived usefulness failed to show significant impact on intention to adopt virtual reality. Virtual reality as a learning tool can appeal to students. But further research need to be conducted to have a better prediction on student intention to use virtual reality for their learning.

INTRODUCTION

The trend of virtual reality (VR) has increased rapidly in the recent years along with the development of technology and easy access to the compatible devices (CubicleNinja, 2019). The number of VR devices are expected to increase 85 percent by 2020, with gaming and educational applications driving most of that growth (Craig and Geogieva, 2017). This trends is also true in education as more companies participate in the VR device market, contents for education applications, and etc. (Craig and Geogieva, 2017). This new and trending technology will surely increases the student's concentration and attention towards education as it did for entertainment. Student would be more likely to learn and know about anything by experiencing with VR (Molfino, 2015). Positive impacts of VR has been demonstrated by many researchers (e.g. Krokos et. al., 2018).

Although, the benefits of VR has been demonstrated in educational settings, it is still considered as an entertainment tool or a training tool in some limited areas, rather than a device that can be adopted in educational environment for improving student learning. It will be interesting to study the perception of HBCU students using VR as a learning tools.

The purpose for this study is to investigate factors that affect students' intention to use VR in the learning. This study views VR as a new technology that is gaining popularity in various areas, especially in education. To be specific, TAM (Technology Acceptance Model) framework was adopted to exam the possible factors that may influence HBCU students' adoption of VR in their learning process.

LITERATURE REVIEW

The use of VR in education can be considered as one of the natural evolutions of computer-assisted instruction or computer-based training (Serafin et al., 2017). Through VR, a learning system can stimulate learner motivation while helping learners visualize and develop abstract

concepts (Christopoulos et al, 2017). In addition, VR features can be used to create a situated learning environment whereby the learner will have the perceived usefulness of VR.

According to Richards (2017), physical schools are becoming almost obsolete. It is apparent that compared to other industries the education sector adoption of VR will eliminate the need for physical contact between students and the teachers. The other industries such as media, retail or manufacturing sectors get the VR helping them to improve on controls and production. The use of VR technologies provides a way to build a low-cost alternative learning environment.

The reasons to use VR in education and training relate particularly to its capabilities. VR can promote the best and probably only strategy that allows students to learn from direct experience. A large number of may fail because they do not master the symbol systems of the disciplines they study, although they are perfectly capable of mastering the concepts that lie at the heart of the disciplines. However, VR can provide a route to success for students who might otherwise fail in our education system (Winn, 1993)

One major advantage of using VR to teach objectives is that it is highly motivating. According to the investigation of Mikropoulos et. al., (1998) on attitude of students towards VR in education, they found students had a favorable attitude towards VR in the education process. This has been documented in the reports of several research studies. Students find it exciting and challenging to walk through a three dimensional environment, and create and interact their own (3D) worlds. Similarly, VR motivates students. It requires interaction and encourages active participation. Some types of VR, for example, collaborative VR using text input with virtual worlds, encourage or require collaboration and provide a social atmosphere (Pantelidis, 1995). Similarly, VR can be used to motivate students by making things more interesting and fun Clark (2006). With VR, students can have experience that are previously impossible.

However, the benefits of using VR may be just temporary phenomenon. Where interaction with a computer replaced customary routines such as listening to the teacher and writing notes, the learning process seems more exciting and fun. Nevertheless, student's novelty faded since such computer-use might itself become routine. Relations with teachers were more relaxed. It is possible that any observed improvements in performance and engagement in students that use VR would be due to the novelty effect, which is the tendency for performance to improve initially when a modern technology is instituted (Molfino, 2015 2017).

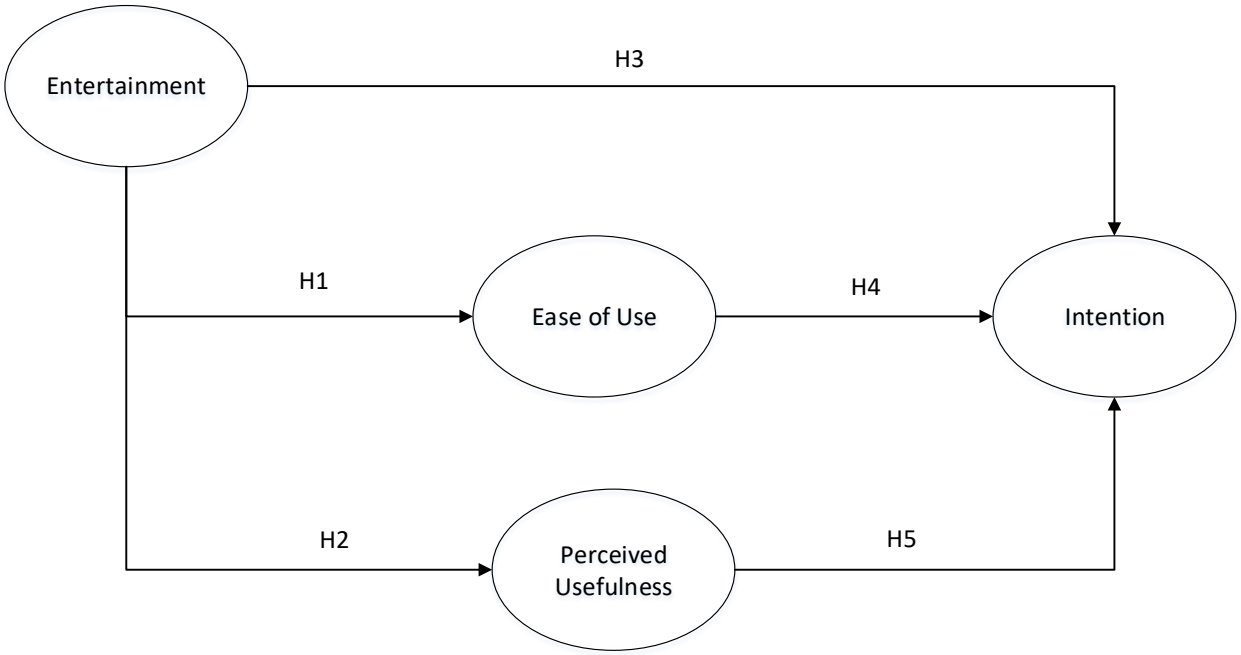
A great deal of research has been conducted on the topic of end-user acceptance with the Technology Acceptance Model (TAM) framework (Stylianou and Jackson, 2007; Venkatesh, et.al., 2003). According to Davis (1986, 1889), the TAM model is a structure where attitude, ease of use, and usefulness are the most important factors that influence user behavioral intention, which is a precedent of actual adoption of technology. The TAM model is also left open to additional variables, such as some demographical variables and factors unique to the system in question. This study develop a research model that predicts that entertainment from using VR affect all of ease of use, usefulness and behavioral intention. And ease of use and usefulness independently are predicted to affect behavioral intention.

The TAM model (David, 1989) predicts end-user acceptance of a system based on two factors: perceived usefulness and perceived ease of use. Perceived usefulness was defined as the degree to which a person believes that using a system enhanced his or her job performance. Perceived ease of use was the degree to which a person believed that using a particular system would be free from effort. Users tend to use a system if it is perceived to be useful and easy.

Entertainment in this study, can be defined as entertaining nature of VR that makes students feel fun and engage in learning. Although student's novelty fade away, studies repeatedly show

that VR improve student attitude and engagement in learning. With VR, students can stay away from one directional lecture and experience previously impossible. Figure1 shows the research model based on the factors discussed above.

Figure 1. Research Model



METHODOLOGY

Data was collected from a survey questionnaire that was administered to students enrolled at a HBCU located in a metropolitan area. The student sample comes from random interactions with students in various school facilities on campus and various classes ranging from freshmen classes to graduate classes.

The survey instrument was developed by modifying the survey from Davis' (1989) study that has been widely cited in the technology adoption literature. The instrument consisted of questions regarding demographics of respondents. The survey includes questions to measure the constructs in the research model, which are four items for perceived ease of use, four items for perceive usefulness, four items for entertainment, and two items for intention.

The hypotheses shown in the research model were tested, using the Partial Least Squares (PLS). PLS has been used to assess various types of construct models (Wetzels, et. al., 2009). PLS, as a structural equation modeling technique, consists of two-part testing of a predictive model: measurement model and structural model testing. The measurement model was tested to evaluate the validity of the questionnaire. And the structural model was examined to test the hypothses in the research model (Barclay et al., 1995). In this study, the model assessment was conducted using the PLS software, Smart PLS2.0.

The Measurement Model

According to Fornell and Larcker (1981), the relationship between constructs in a research model and items used to measure them can be specified as either formative or reflective. Formative items are considered causes of the construct. Reflective items are considered effects of the construct. In order to specify the relationship, theoretical knowledge must be applied as much as possible (Lohmoller, 1981). Lohmoller also suggests that exogenous constructs (independent variables) should be modeled with formative items (multiple items form a construct) and endogenous constructs (dependent variables) should be modeled with reflective items (a construct is reflected in multiple items) when theoretical knowledge about the construct does not exist. For the proposed model shown in Figure 1, the items measuring all of exogenous constructs were considered formative, whereas the items measuring all of endogenous constructs were considered reflective (see Table 1 below).

Table 1. Measurement Model

Constructs	Model	Relationship
Entertainment	Exogenous	Formative
Ease of Use	Endogenous	Reflective
Perceived Usefulness	Endogenous	Reflective
Intention	Endogenous	Reflective

The Structural Model

The test of the structural model is to investigate the significance of the hypotheses in the research model. The results show the strengths (coefficients) of relationships specified in the model and the significance level of the relationship between the constructs in the research model. In addition, the test shows R^2 value of the dependent variables, which indicates the amount of variance explained by the model. In other words, the test show the predictive power of the model. The hypotheses were tested by assessing the significance of the relationships between the constructs.

RESULTS

Profiles of the Samples

Table 2 shows some demographic information about the respondents. The sample consisted of 54 percent females and 46 percent males, with average age of 28 years. Computer Information Systems appears to be the biggest major with 41percent, although the majority came from various majors. Approximately 54 percent of the students have used VR for their learning. In addition, the majority of students prefer learning environment where they have access to visual aids or hands on activities.

The following sections describe the evaluations of the proposed constructs and the research model; that is the impact of predictor variables on student's intention to use VR as a learning tool.

Measurement Model

The measurement model addresses the relationship between the constructs and the items used to measure them. The test of the measurement model consists of the estimation of the convergent and discriminant validity of the measurement instrument.

Table 2. Demographic Variables	
	N=138(%)
Gender:	
Male:	63(46)
Female:	75(54)
Average Age:	28
Major:	
Computer Information System:	41(30)
Biology:	20(15)
Business:	19(14)
Social Work:	10(7)
Forensic Science	20(14)
Criminal Justice	10(7)
Educational Studies	11(8)
Math	7(5)
Have you used Virtual Reality?	
Yes	75(54)
No	63(46)
Have you ever used Virtual Reality for your learning?	
Yes	54(39)
No	84(61)
What is your learning style?	
I learn best if I use visual aids	46(33)
I learn best if I listen lectures	27(20)
I learn best if I see people doing tasks	13(9)
I learn best with hands on activities	52(38)

Convergent validity refers to the extent to which alternative measures of the same construct are related to each other. Three tests have been used to estimate convergent validity: (1) composite reliability; (2) factor loadings of the items; and (3) average variance extracted (AVE), which indicates the capacity of the manifested variables (measurement items) to describe the related latent variable (construct). The composite reliability was assessed using the criteria (.70) suggested by Fornell and Larcker (1981). Average variance extracted (AVE) of 0.50 or above has also been used to support the convergent validity of the constructs (Fornell and Larcker, 1981). Factor loadings of at least 0.70 are considered to be acceptable (Barclay et al., 1995). However, it has been suggested that absolute value of factor loadings of .30 are considered to meet the minimal level, loadings of 0.40 are considered more significant, and loadings of 0.50 or greater are considered very significant (Hair et al., 1998).

As shown in Table 3, the composite reliability of all reflective constructs is above 0.80 or very close to 0.80. These values are greater than the cut-off value of 0.70 suggested by Fornell and Larcker (1981). This shows strong internal consistency. Table 3 also describes average variance extracted for the constructs of the model. All of the reflective constructs are over 0.50 for the average variance extracted. In conclusion, the convergence validity appears to be strong.

Table 4 shows that majority of the reflective constructs had loadings of over 0.70 except for two items. In order to achieve discriminant validity, no item should load higher on other constructs than it is on the construct it is intended to measure (Hair, et al., 1998). All items loaded highest on their target construct. Overall, the analysis shows positive results of the reliability and validity of the items to measure the constructs.

Table 3. Average Variance Extracted and Reliability

Constructs	AVE	Composite Reliability
Entertainment		
Ease Of Use	0.56	0.82
Intention To Use	0.65	0.79
Perceived Usefulness	0.82	0.95

Table 4. Discriminant Validity

Items	Entertainment	Ease Of Use	Intention to Use	Perceived Usefulness
ENT1	**0.91**	0.70	0.48	0.70
ENT2	**0.91**	0.71	0.45	0.70
ENT3	**0.92**	0.67	0.41	0.77
ENT4	**0.83**	0.53	0.43	0.73
EOU1	0.10	**0.35**	0.08	0.03
EOU2	0.49	**0.77**	0.29	0.41
EOU3	0.67	**0.88**	0.39	0.57
EOU4	0.70	**0.87**	0.40	0.52
IU1	0.30	0.21	**0.70**	0.23
IU2	0.47	0.44	**0.91**	0.35
PU1	0.75	0.55	0.32	**0.90**
PU2	0.74	0.54	0.34	**0.93**
PU3	0.74	0.48	0.35	**0.90**
PU4	0.69	0.57	0.34	**0.88**

Structural Model

Figure 2 shows the significance and the strength of the relationships between the constructs. It also shows R^2 which indicates the predictive power of the model. Entertainment shows significant impact on both Ease of Use and Perceived Usefulness, with path coefficients of 0.73 and 0.81 respectively (H1 and H2). Also, Entertainment is the only significant predictor of

Student Intention to use VR for their learning, with path coefficients of 0.45(H3). However, Ease of Use and Perceived Usefulness, which have been most important predictor of intention, failed to show significant impact on Student Intention, with path coefficients of 0.15 and -0.08 respectively (H4 and H5). Regarding the explanatory power of the research model, Ease of Use, Perceived Usefulness, and Student Intention shows R^2 of 0.54, 0.65, and 0.26 respectively. Table 5 shows a summary of the hypotheses testing along with the t-statistics.

Figure 2: Path Coefficients and R^2

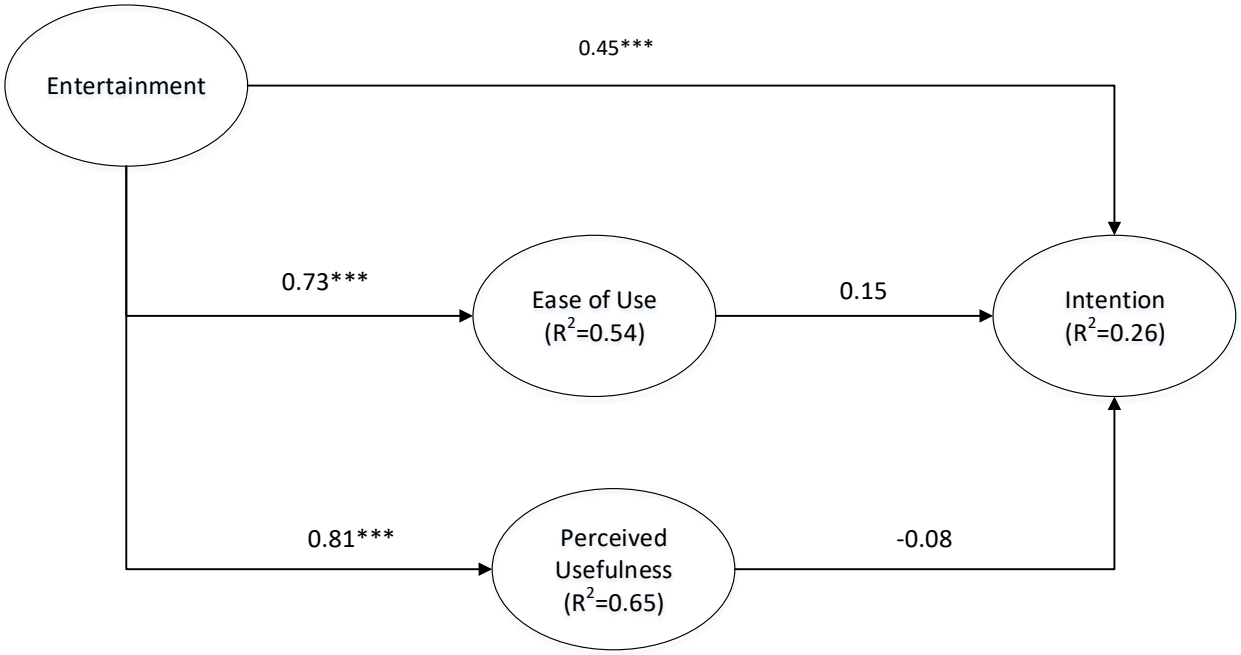


Table 5. Hypotheses Test Results

Hypotheses	t-statistics	Results
H1: Entertainment aspect of virtual reality will influence students' perception of ease of use.	19.05	**Supported**
H2: Entertainment aspect of virtual reality will influence students' perceived usefulness.	6.21	**Supported**
H3: Entertainment aspect of virtual reality will influence students' intention to use virtual reality.	14.94	**Supported**
H4: Students' perception of ease of use will influence student intention to use virtual reality.	1.02	Not Supported
H5: Students' perception of usefulness will influence student intention to use virtual reality.	0.49	Not Supported

CONCLUSION

This study investigated HBCU students' adoption of VR for their learning, based on the Technology Adoption Model. The findings showed that entertaining nature of VR is a significant predictor for all variables (ease of use, usefulness, and intention to adopt VR) included in the research model. Surprisingly both ease of use and usefulness, which are historically the most significant factors, failed to be significant predictors for the intention. This may be because surveyed students do not consider VR as a learning tool. Nevertheless, the raw data revealed that students are willing to use VR for their education.

It should be noted that the student demographic data matches statistics reported by the Board of Regent which oversees the school where student sample is from. These students are mature non-traditional students who work before and after school. Anecdotal evidence shows that they are very disciplined and successful in traditional classroom settings, although the results show they prefer classes with hand-on activities and visual aids. Maybe they don't care much about entertaining nature of VR when it comes to their education.

Another major issue in the study is the research model that might be over simplified and omit other important factors such as culture, that are demonstrated as important factors in recent the TAM model related studies. Although application of VR is rapidly expanding in various areas, especially education and training, many schools are adopting VR in some limited classes only. Additional studies can extend this research by examining compatibility between VR and course contents. Finally, it may be useful to wait until students gain some experience with VR in classroom environment and instructors accept this new technology as a new course delivery method.

REFERENCES

Barclay, D., Higgins, C., and Thompson, R. (1995). The Partial Least Squares (PLS) Approach to Causal Modeling, Personal Computer Adoption and Use as an Illustration. Technology Studies. 2(2), 285-309.

Craig, E., and Georgieva. M. (2017). Introducing the VR and AR Series: Stepping Into the New Frontier of Learning Series. Educause Review, June.

Christopoulos, A., Conrad, M., & Shukla, M. (2017). Increasing student engagement through virtual interactions: How? Virtual Reality. doi:10.1007/s10055-017-0330-3

CubicleNinja (2019). https://cubicleninjas.com/2019/01/14/2019-virtual-reality-trends/

Davis, F. (1986), A Technology Acceptance Model for Empirically Testing New End-User Information Systems: Theory and Results, Doctoral Dissertation, MIT Sloan School of Management, Cambridge, MA.

Davis, Fred D. (1989), "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," MIS Quarterly 3(3), 319-40.

Fornell, C., and Larcker, D.F. (1981). Evaluating Structural Equation Model with Unobservable Variables and Measurement Error. Journal of Marketing Research. 18, 39-50.

Hair, J.F., Tatham, R.L., and Black, W. (1998). Multivariate Data Analysis, Prentice-Hall, New Jersey.

Krokos, E., and Plaisant, C., and Varshney, A., (2018). Virtual memory palaces: immersion aids recall. Virtual Reality.

Lohmoller, J.B. (1981). LVPLS 1.6: Latent Variable Path Analysis with Partial Least Squares. University of the Federal Armed Forces, Munich.

Mikropoulos, T., Chalkidis, A., Katskikis, A., &Emvalotis, A. (1998). Students' attitudes towards educational virtual environments. Education and Information Technologies, 3(2), 137-148.

Molfino, A., (2015). The Potential (and Challenges) for Virtual Reality in Education. Linkedin. Retrieved from https://www.linkedin.com/pulse/potential-challenges-virtual-reality-education-agustin-molfino

Pantelidis, V. S. (1995). Reasons to use virtual reality in education. VR in the Schools, 1(1), 9. Retrieved from http://vr.coe.ecu.edu/vrits/1-1pante.htm

Richards, B. D. (2017). Virtual- and Augmented-Reality Platforms for Student Learning opportunities. doi:10.1130/abs/2017am-303005

Serafin, S., Adjorlu, A., Nilsson, N., Thomsen, L., &Nordahl, R. (2017). Considerations on the use of virtual and augmented reality technologies in music education. 2017 IEEE Virtual Reality Workshop on K-12

Stylianou, A. and Jackson, P. (2007) "A comparative Examination of Individual Differences and Beliefs on Technology Usage: Gauging the Role of IT," The Journal of Computer Information Systems, Summer 2007, 47 (4), pp. 11-18.

Venkatesh ,V., Morris, M., Davis, G., & Davis, F. (2003). User Acceptance of Information Technology: Toward a Unified View. MIS Quarterly, 27(3):425-478.

Wetzels, M., Schroder, G., and Oppen, C.V. (2009). Using PLS Path Modeling for Assessing Hierarchical Construct Models: Guidelines and Empirical Illustration. MIS Quarterly, 33(1) 177-195.

Winn, W. (1993). A conceptual basis for educational applications of virtual reality (Technical Report TR-93-9). Seattle, Washington: Human Interface Technology Laboratory, University of Washington. Retrieved from http://www.hitl.washington.edu/publications/r-93-9/