Comparing the Performance of an Immersive Virtual Reality and Traditional Desktop Cultural Game

Brian An, Forrest Matteo, Matt Epstein and Donald E. Brown
[1]*Department of Systems and Information Engineering, University of Virginia, Charlottesville, VA, U.S.A.*

Keywords: Virtual Reality, Serious Games, Cross Cultural Competence.

Abstract: The recent popularization and affordability of Head Mounted Display (HMD) Virtual Reality (VR) systems such as the Oculus Rift has accelerated the expansion of the application of these devices beyond entertainment. One of the targeted areas of expansion is in social interaction serious games where it has been often hypothesized that the immersion of HMD VR would increase the learning effectiveness of these systems. Despite this growth, few studies in the literature examine the effectiveness of these types of games in HMD VR as compared to more traditional desktop systems. This study evaluates the performance difference between a traditional desktop version and an HMD VR version of a cultural serious game designed to teach U.S. Army soldiers how to communicate competently with Chinese soldiers in a joint humanitarian mission. The study found no performance difference between participants who played the desktop or the HMD VR version of the game. The study did find a strong positive interaction correlation between gender and participants who played the HMD VR version of the game. These findings motivate further research into why this correlation exists and if, through game design, can also be instilled in female participants.

1 INTRODUCTION

As the world becomes more interconnected through global business and coalition military operations, it has become a necessity for individual's to exhibit Cross Cultural Competence (3C). 3C is characterized by the Department of Defense as the "set of knowledge, skills, and affect/motivation that enable individuals to adapt effectively in cross-cultural environments(Gallus et al., 2014)." This study evaluates the effectiveness of a game designed to improve 3C delivered in a Head-Mounted Display (HMD) Virtual Reality (VR) to the more traditional desktop version of the game. While the evolution of HMD VR technology has garnered much attention with the introduction of devices such as the Oculus Rift and the HTC Vive, few studies have empirically assessed the added effectiveness of HMD VR systems over traditional desktop channels in improving social-interaction skills such as 3C. This study specifically investigates the effectiveness of a 3C training game presented in both HMD VR and a traditional desktop medium in order to inform future investments of 3C training systems.

2 PREVIOUS WORK

Since the introduction of game-based learning, 3C games have taken many forms(Fowler and Pusch, 2010). One of the first games, BAFA BAFA™, was designed as a moderated board game where participants would take on the role of fictional cultures and attempt to communicate and collaborate with other participants(Fowler and Pusch, 2010).

As gaming technologies improved and theories behind 3C evolved, more sophisticated computer-based games emerged(Lane et al., 2013)(Tasdemir and Prasolova-Førland, 2014)(Fishwick et al., 2008). These games targeted various aspects of 3C to include communication, negotiation, culture-specific knowledge, and behavioral norms.

Though these games have demonstrated varying degrees of effectiveness in improving 3C, one area that has yet to be investigated is the use of highly immersive modern VR systems to train 3C. Given the cognitive and sensory attributes associated with 3C, it would seem highly plausible that VR could be a better learning environment for 3C than the more traditional digital means previously described(Van Dyne et al., 2012)(Matsumoto and Hwang, 2013).

An, B., Matteo, F., Epstein, M. and Brown, D.
Comparing the Performance of an Immersive Virtual Reality and Traditional Desktop Cultural Game.
DOI: 10.5220/0006922800540061
In *Proceedings of the 2nd International Conference on Computer-Human Interaction Research and Applications (CHIRA 2018)*, pages 54-61
ISBN: 978-989-758-328-5

2.1 Virtual Reality

At its most abstract definition, Virtual Reality has been defined as "an artificial environment which is experienced through sensory stimuli (as sights and sounds) provided by a computer and in which one's actions partially determine what happens in the environment(Merriam-Webster Online, 2017)." Given this definition, the term Virtual Reality is interchangeably used for a wide variety of technologies and experiences. Previously, Virtual Reality described lower quality and lower specification systems using computer or projection screens to display content(Freina and Ott, 2015). Compared to today's standards of interaction and immersion, these systems would hardly be considered virtual reality. Modern virtual reality systems, however, take many forms. Of these systems, two technologies have emerged as industry leaders: Cave Automatic Virtual Environments (CAVE) and Head-Mounted Display Virtual Reality(HMD VR) systems.

Though many configurations of CAVE systems exist, an example of a CAVE system consists of four projection screens to serve the content using stereo projection. Within the the environment, users wear a set of tracked equipment ranging from simple 3D glasses to full body suits to capture all body motion. Generally, tracking is conducted either with inertial sensors or more commonly with infrared markers(Kageyama and Tomiyama, 2016)(Katsouri et al., 2015).

HMD VR systems utilize a notably different methodology to achieve immersion. HMD VR systems consist of a goggle-like headset which projects an independently rendered image for each eye which corrects for interpupillary distance. The HMD position is tracked (typically with infrared markers) in order to accurately render and project the appropriate image of the head-based gaze direction. Rapid refresh rates of the projection allow for users to naturally move their head and continuously see a real-time 360 degree stereo projection of the scene (See Fig 3). Due to its widespread commercial adoption and optimized content development tools, HMD VR systems have been the target of many commercial entertainment and educational research ventures(Bastiaens et al., 2014)(Freeman et al., 2017).

2.2 Immersive VR DGBL Systems

Recent innovations and cost-efficiencies with immersive HMD VR have spurred a lot of interest with its use in digital game based learning (DGBL) systems specifically where sensory immersion is hypothesized to augment learning benefits. Freina et al. propose that VR can add learning value in situations that "cannot be physically accessed(Freina and Ott, 2015)." They postulate that this limitation can be due to a number of reasons to include temporal limitations (i.e. situation occurred in a historic time period), safety limitations (i.e. hostile or emergency situations), and ethical limitations (i.e. performing a high-risk surgery by non-experts). Though studies have shown that immersive technologies such as HMD VR can increase Quality of Experience and Engagement, there is a lack of empirical evidence comprehensively characterizing the learning advantages and performances of these technologies(Hupont et al., 2015).

Freeman et al. conducted a comprehensive literature review of empirical studies of the use of virtual reality in mental health treatments and found large inconsistencies in the use of the term 'virtual reality' with many of the recent studies not actually referring to modern VR as previously described(Freeman et al., 2017). In the experiments that, in fact, did experiment with modern VR, results were mixed. In one instance, a research group found no difference in performance between an HMD VR and a desktop version of DGBL system designed to teach Spatial Perspective Taking to mildly intellectually impaired teenagers(Freina and Ott, 2015)(Freina et al., 2016).

Also, several studies have assessed the impact of immersive VR on teaching various academic concepts. A research group found that when participants performed a musical signal flow task in HMD VR versus a traditional computer screen, no performance difference was found(Tackett, 2016). Makransky et al. conducted an experiment comparing immersive VR an a traditional screen to teach science concepts. Using electroencephalogram (EEG) measurements, they found that though immersive VR increased sense of presence, it also resulted in poorer learning outcomes(Makransky et al., 2017). On the contrary, other studies have shown positive learning results in immersive VR(Alhalabi, 2016)(Webster, 2016). In the area of academic learning systems, the current research is inconclusive as to whether immersive VR results in better learning.

In the area of social and cultural serious games, we found a limited number of studies evaluating performance in immersive VR. One related area of research addresses the effects of immersive VR in treating cognitive and social disabilities. Several studies have shown promising results in the use of immersive VR to treat High-Functioning Autistic children though the results are far from conclusive and further research is recommended before any treatment recommendations are considered(Bashiri et al., 2017)(Bradley and Newbutt, 2018). Therefore, the limited number of studies make it necessary to further investigate the learning benefits of social and cultural serious games.

2.3 Immersion and Gender

Previous studies comparing various levels of immersive game environments have shown differences in learning performance between males and females. Though no studies were found evaluating modern immersive VR systems, several studies compared traditional or lower fidelity VR systems to lower immersion systems and found that males generally performed better.

Given previous findings that females use virtual spaces for communal purposes, Coffey et al. hypothesized that females would score higher in a 3D virtual environment (non HMD-VR) versus a static web environment(Guadagno et al., 2011)(Coffey et al., 2017). However, from their experiment, they found the opposite to be true and that, in fact, males showed more improvement in the 3D virtual environment than females.

In an experiment measuring recall after being delivered a lecture in VR, Bailenson et al. found that males performed significantly better than females(Bailenson et al., 2008). They hypothesized that these gains could be attributable to findings reporting that men were more experienced using videogames(Yee, 2006).

Ausburn et al. specifically investigated the gender effect in virtual learning environments and proposed a theoretical framework to explain the difference(Ausburn et al., 2009). They hypothesized that these differences can be attributed to gender differences in “Technology Self-Efficacy” characterized by a set of experiences, skills, and perceptions that various studies have also shown gender differences (See Fig 1)(Ausburn et al., 2009).

Though our literature review did not find any specific studies that found similar gender differences in modern immersive VR systems, the previously mentioned studies would lead one to believe that males would also achieve better results in these systems.

3 RESEARCH QUESTIONS

The primary research question of this study is to investigate whether a 3C game played in immersive HMD VR has a significant effect on the acquisition of 3C as compared to a game played on a traditional desktop medium. Given previous works related to HMD VR, we hypothesize the following:

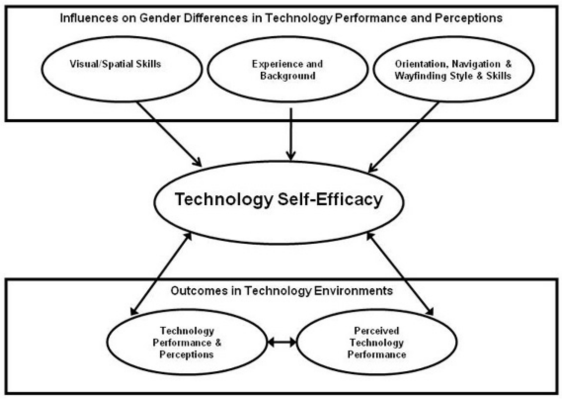

Figure 1: Ausburn‘s theoretical framework explaining gender differences in virtual learning environments(Ausburn et al., 2009).

- **H1:** Participants exposed to the HMD VR version of the CMTS will exhibit greater improvement than those that are exposed to the desktop version.
- **H2:** Males exposed to the HMD VR version of the CMTS will exhibit greater improvement than females.

4 EXPERIMENTAL DESIGN

Our experimental design was a 2 (Game Version) x 2 (Gender) mixed factorial design. Using a randomized-block design, participants were randomly assigned to either the traditional or VR group blocking for reported Cultural Intelligence (CQ) score. Cultural Intelligence is a self-report inventory designed to evaluate a participants 3C developed by Van Dyne et al(Van Dyne et al., 2012). Recent independent studies have shown the CQ model to be a promising measure of 3C and related personality traits(Matsumoto and Hwang, 2013)(Alon et al., 2018)(Chua and Ng, 2017). In order to ensure an even distribution of pre-experiment 3C, participants were blocked around a predetermined CQ score threshold.

4.1 Stimuli

The stimuli used in this study was a custom developed serious game designed to teach participants Cross Cultural Competence. The game was designed using the Cultural Simulation Design Process(An et al., 2017). The game is comprised of two military training scenarios whereby the participant plays the role of a US Army Officer in charge of humanitarian efforts. In each scenario, the player is expected to work with a Chinese People’s Liberation Army Officer in order to conduct joint humanitarian efforts. Players are presented with dialogue options of varying degrees of appropriateness. When a dialogue option is selected, a feedback system provides specific guidelines as to why a particular selection was or was not appropriate. In the first scenario called the Disaster Management Exercise (DME) scenario, US and Chinese forces are working together to provide disaster relief to an Ebola-stricken community in the Liberian Lowlands (see Fig 2). In the second scenario called the Earthquake scenario, US and Chinese forces are providing aid and assistance to injured civilians after a deadly earthquake in Nsunga, Tanzania. Both versions of the game had identical visual and dialogue content.

Figure 2: The player is interacting with the PLA Officer-in-Charge in the DME Scenario of the HMD VR game.

4.1.1 Desktop Variant

Though both versions of the game have identical visual and dialogue content, each game version has notable differences in User Interface. The Desktop version has a locked camera preventing the user from changing what was visible on the screen. The dialogue system is locked to the bottom of the viewing area and the primary mode of user interaction is by clicking on the preferred dialogue option.

4.1.2 HMD VR Variant

The HMD VR version of the game has a notably different user experience and User Interface. This version was developed specifically for the Oculus Rift CV1 HMD VR system (see Fig 3). First, the camera motion is tied to the motion-tracking system of the Oculus Rift. This allows the participant to see the entire scene around the player. Second, the dialogue system is presented as a floating dialogue box as scene in Fig 2. Dialogue selections are made through prolonged gaze and simultaneous controller selection on the preferred option.

Figure 3: A participant playing the HMD VR version of the game.

4.2 Participants

21 participants (Male=12, Female=9) were recruited for the experiment. The distribution of participants was 11 Reserve Officer Training Corp (ROTC) cadets and 10 non-military affiliated participants. The participants mean age was 20.58 years (Median = 21, SD = 1.06). Participants were equally split into the HMD VR group (n=11) and the Desktop group (n=10). For completing the experiment, each participant was compensated with a $20 gift card.

4.3 Procedures

Students were individually assessed. Participants were first e-mailed an online survey intended to capture basic demographic information as well as their CQ score. This information was used to ensure equal representation in the test and control group while blocking for the relevant factors. When participants arrived for the experiment, they were first administered the pre-test. Following the pre-test, participants engaged in a tutorial specific to the game version they were playing. Following the tutorial, participants played both the DME and Earthquake scenario of the game. Once the game was complete, the participants were administered the post-test as well as a feedback survey to gauge user experience. The entire testing process for a single participant was approximately one hour. See Fig 4.

4.4 Measures

The pre-test and post-test used to determine performance improvement were conducted as real-time dia-

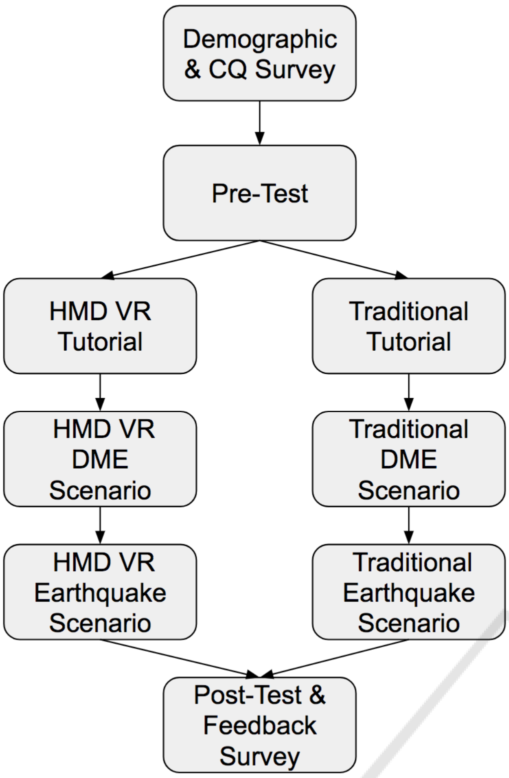

Figure 4: Experiment Flow.

logue situational judgment test (SJT). SJTs have often been use to evaluate 3C though previous versions have typically been written exams with multiple choice responses(Lane et al., 2013)(Wray et al., 2009). Though traditional SJTs have been effective in measuring cognitive and metacognitive thought processes, they do not capture any performance with respect to culturally appropriate communication and behaviors. As such, we adapted the SJT to be a role-playing dialogue with a Chinese actor hereby referred to as the role-playing SJT (rSJT). The rSJT is initiated by presenting the participant with a scenario dossier which describes the role the player must play as well as the objectives that player is trying to achieve through the dialogue. Once the participant has read through the dossier, the actor initiates the conversation with a scripted initial response at which point the conversation becomes unscripted and free-flowing.

The rSJTs are audio visually recorded and these recordings are then rated by independent Chinese cultural experts for cultural proficiency. The experts score the rSJTs with a previously developed rubric which then produces a numeric score for each rSJT. In order to ensure the reliability of the ratings, a Cohen's Kappa is calculated on the ratings(Fleiss and Cohen, 1973).

Table 1: Cultural Intelligence Sub-Dimension Model.

Main Dimension	**Sub-Dimension**
Cognitive	Cultural General Knowledge
	Context Specific Knowledge
Motivation	Intrinsic Motivation
	Extrinsic Motivation
	Self Efficacy to Adjust
Metacognitive	Planning
	Awareness
	Checking
Behavior	Verbal Behavior
	Non-Verbal Behavior
	Speech Acts

4.5 Data

4.5.1 Collection

Between the demographic survey and the CQ inventory, a variety of data was collected on each participant. The demographic survey consisted of two categories of items characterized by 1) Personal Information and 2) International Exposure for a total of 12 unique survey items. The previously described CQ inventory is composed of 37 items subsetted into 4 main factors and 11 sub-factors (see Table 1 (Van Dyne et al., 2012). The score of each main factor or sub-factor is calculated as the average of each of the items within the main factor or the sub-factor.

4.5.2 Analysis Methods

Multiple Linear Regression was the primary method used to identify any performance increases with respect to the pre/post test and the independent factors collected in the experiment. Initial factor sets were based upon factors found to be relevant in previous studies as well as those that theoretically showed the most promise. In order to identify the most significant models, AIC-based Stepwise regression was utilized to determine the most significant models(Akaike, 1987).

5 RESULTS

The results are organized by the hypotheses previously described.

5.0.1 H1 Analysis Results

Participants exposed to the HMD VR version of the CMTS will exhibit greater improvement than those that are exposed to the desktop version.

To examine the hypothesis H1, a Welch's t-test was performed between the HMD VR group and the desktop group with respect to the performance improvement. This t-test realized an insignificant difference (t=0.47931, df=15,521, p=0.6384).

Additionally a multiple linear regression model was generated with the independent behaviors consisting of the Metacognitive and Behavior subdimensions of CQ as well as various demographic factors as shown in Table 2. The Metacognitive CQ component "reflects the mental capability to acquire and evaluate cultural knowledge.(Van Dyne et al., 2012)" The Behavior CQ component "reflects the capability to flex behaviors to fit different cultural contexts.(Van Dyne et al., 2012)" The Metacognitive and Behavior CQ components were considered in the model for their specific relevance to skills that we hypothesized would impact the pre-test and post-test scores.

This model showed a negative significant correlation for those participants in the HMD VR group. An AIC stepwise regression of that model also resulted in a similar negative significant correlation as seen in Table 3.

5.0.2 H2 Analysis Results

Males exposed to the HMD VR version of the CMTS will exhibit greater improvement than females.

With respect to H2, we explored the significance of an interaction effect between gender and VR. The linear regression model shown in Table 2 showed a significant interaction effect as seen in the model as "VR:genderMale." Additionally, the AIC stepwise regression resulted in a similar effect though the "VR:genderMale" interaction effect was removed as seen in Table 3.

6 DISCUSSION

The findings are discussed by the previously stated hypotheses.

The first hypothesis investigates whether the HMD VR variant of a game results in more learning performance as compared to the traditional desktop variant. We found that, generally, the two variants did not perform differently when other factors were not considered. Additionally, when the test group was considered along with the demographic factors, it was found that generally the HMD VR group performed slightly worse that the control group as shown in Tables 2 and Table 3. This finding parallels the results of studies in other domains that found no difference or a negative impact for HMD VR(Tackett, 2016)(Makransky et al., 2017). It is possible that the perceptual

Table 2: Initial Regression Model of Performance Improvement.

	Dependent variable:
	Improvement
VR	-0.356^{*} (0.187)
meta_Planning	-0.117^{*} (0.064)
meta_Awareness	0.035 (0.103)
meta_Checking	0.364^{***} (0.105)
beh_Verbal	0.062 (0.084)
beh_Non_Verbal	0.097 (0.054)
beh_Speech	-0.202^{*} (0.095)
genderMale	−0.073 (0.184)
ROTC	0.169 (0.140)
VR:genderMale	0.484^{**} (0.180)
VR:ROTC	0.169 (0.184)
Constant	-1.531^{**} (0.574)
Observations	21
Adjusted R^2	0.595
RSE	0.173 (df = 9)
F Statistic	3.672^{**} (df = 11; 9)
Note:	$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

Table 3: AIC Stepwise Regression Model of Performance Improvement.

	Dependent variable:
	Improvement
VR	-0.277^{*} (0.148)
meta_Planning	−0.082 (0.047)
meta_Checking	0.356^{***} (0.075)
beh_Non_verbal	0.107^{*} (0.050)
beh_Speech	-0.170^{**} (0.062)
GenderMale	−0.091 (0.164)
ROTC	0.292^{***} (0.084)
VR:genderMale	0.466^{**} (0.166)
Constant	-1.407^{**} (0.503)
Observations	21
Adjusted R^2	0.647
RSE	0.161 (df = 12)
F Statistic	5.575^{***} (df = 8; 12)
Note:	$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

realism added through HMD VR is in fact distracting. Through EEG measurements, Makransky et al. found that HMD VR increased cognitive load as compared to desktop versions of the same biology lab learning system. They explained that this increased load may overload participants and thus "result in less opportunity to build learning outcomes.(Makransky et al., 2017)"

In analyzing the results for the second hypothesis, we discovered a more nuanced explanation to the conclusion drawn from the first hypothesis. The second order effect between participants who were male and were in the HMD VR test group was found to be highly significant. The positive coefficient of this interaction would lead one to conclude that HMD VR does, in fact, have a positive effect on learning outcomes for males. This extends the findings of previous studies that have also found correlation between higher immersion digital learning systems and gender(Coffey et al., 2017)(Ausburn et al., 2009). Specifically, we conclude that this correlation between immersion and gender can be extended through the immersive experience of HMD VR. Causality of this finding continues to be an open question that requires further investigation though the theoretical construct of technological self efficacy is supported by our finding has well as other independent findings(Ausburn et al., 2009).

7 LIMITATIONS

A notable limitation in this study is the relatively small sample size used in this experiment. Due to the specific military-based application of the stimuli, the pool of participants with ROTC backgrounds in the local area was small. Future studies should be conducted in areas with a higher concentration of military participants in order to facilitate the recruitment of military personnel.

8 CONCLUSION

This study has further advanced our understanding of the impacts of using highly immersive virtual environments in social and cultural DGBL systems as well as the specific factors that explain these impacts. We found that generally more immersive systems (e.g. HMD VR) do not necessarily result in better learning outcomes in a cultural DGBL system. However, the strong interaction found between HMD VR and male participants also indicates that demographic factors such as gender should be considered when developing cultural DGBL systems and, perhaps, all types of DGBL systems. This study motivates further research with highly immersive DGBL systems in other domains in order to draw more concrete conclusions about general immersive systems beyond those drawn in this study.

ACKNOWLEDGEMENTS

We would like to acknowledge our Chinese actors and raters Wen Ding, Xiang Gao, Yichen Jiang, Chang Xu, Yingjie Liu, and Wanyi Duan for administering the pre/post test and rating the pre/post test recordings. Additionally, we would like to thank our partners at the United States Military Academy for their support in developing the cultural content in the CMTS.

We would also like to thank the creators of the Stargazer R package for contributing to the R community of researchers(Hlavac, 2015).

REFERENCES

Akaike, H. (1987). Factor analysis and aic. *Psychometrika*, 52(3):317–332.

Alhalabi, W. S. (2016). Virtual reality systems enhance students achievements in engineering education. *Behaviour & Information Technology*, 35(11):919–925.

Alon, I., Boulanger, M., Elston, J. A., Galanaki, E., Martínez de Ibarreta, C., Meyers, J., Muñiz-Ferrer, M., and Vélez-Calle, A. (2018). Business cultural intelligence quotient: A five-country study. *Thunderbird International Business Review*, 60(3):237–250.

An, B., Brown, D. E., Hazell, R. M., and Grazaitis, P. (2017). Cultural dimension theory based simulations for us army personnel. In *International Conference on Social Computing, Behavioral-Cultural Modeling and Prediction and Behavior Representation in Modeling and Simulation*, pages 65–70. Springer.

Ausburn, L. J., Martens, J., Washington, A., Steele, D., and Washburn, E. (2009). A cross-case analysis of gender issues in desktop virtual reality learning environments.

Bailenson, J. N., Yee, N., Blascovich, J., Beall, A. C., Lundblad, N., and Jin, M. (2008). The use of immersive virtual reality in the learning sciences: Digital transformations of teachers, students, and social context. *The Journal of the Learning Sciences*, 17(1):102–141.

Bashiri, A., Ghazisaeedi, M., and Shahmoradi, L. (2017). The opportunities of virtual reality in the rehabilitation of children with attention deficit hyperactivity disorder: a literature review. *Korean journal of pediatrics*, 60(11):337–343.

Bastiaens, T., Wood, L., and Reiners, T. (2014). New landscapes and new eyes: The role of virtual world design for supply chain education. *Ubiquitous Learning*, 6(1):37–49.

Bradley, R. and Newbutt, N. (2018). Autism and virtual reality head-mounted displays: A state of the art systematic review. *Journal of Enabling Technologies*, 11.

Chua, R. Y. and Ng, K. Y. (2017). Not just how much you know: Interactional effect of cultural knowledge and metacognition on creativity in a global context. *Management and Organization Review*, 13(2):281–300.

Coffey, A. J., Kamhawi, R., Fishwick, P., and Henderson, J. (2017). The efficacy of an immersive 3d virtual versus 2d web environment in intercultural sensitivity acquisition. *Educational Technology Research and Development*, 65(2):455–479.

Fishwick, P. A., Henderson, J., Fresh, E., Futterknecht, F., and Hamilton, B. D. (2008). Simulating culture: an experiment using a multi-user virtual environment. In *Simulation Conference, 2008. WSC 2008. Winter*, pages 786–794. IEEE.

Fleiss, J. L. and Cohen, J. (1973). The equivalence of weighted kappa and the intraclass correlation coefficient as measures of reliability. *Educational and psychological measurement*, 33(3):613–619.

Fowler, S. M. and Pusch, M. D. (2010). Intercultural simulation games: A review (of the united states and beyond). *Simulation & Gaming*, 41(1):94–115.

Freeman, D., Reeve, S., Robinson, A., Ehlers, A., Clark, D., Spanlang, B., and Slater, M. (2017). Virtual reality in the assessment, understanding, and treatment of mental health disorders. *Psychological medicine*, 47(14):2393–2400.

Freina, L., Bottino, R., Tavella, M., and Dagnino, F. (2016). Immersions impact on performance in a spatial reasoning task. In *International Conference on Games and Learning Alliance*, pages 211–220. Springer.

Freina, L. and Ott, M. (2015). A literature review on immersive virtual reality in education: state of the art and perspectives. In *The International Scientific Conference eLearning and Software for Education*, volume 1, page 133. " Carol I" National Defence University.

Gallus, J. A., Gouge, M. C., Antolic, E., Fosher, K., Jasparro, V., Coleman, S., Selmeski, B., and Klafehn, J. L. (2014). Cross-cultural competence in the department of defense: an annotated bibliography. Technical report, DTIC Document.

Guadagno, R. E., Muscanell, N. L., Okdie, B. M., Burk, N. M., and Ward, T. B. (2011). Even in virtual environments women shop and men build: A social role perspective on second life. *Computers in Human Behavior*, 27(1):304–308.

Hlavac, M. (2015). *stargazer: Well-Formatted Regression and Summary Statistics Tables*. Harvard University, Cambridge, USA. R package version 5.2.

Hupont, I., Gracia, J., Sanagustín, L., and Gracia, M. A. (2015). How do new visual immersive systems influence gaming qoe? a use case of serious gaming with oculus rift. In *Quality of Multimedia Experience (QoMEX), 2015 Seventh International Workshop on*, pages 1–6. IEEE.

Kageyama, A. and Tomiyama, A. (2016). Visualization framework for cave virtual reality systems. *International Journal of Modeling, Simulation, and Scientific Computing*, 7(04):1643001.

Katsouri, I., Tzanavari, A., Herakleous, K., and Poullis, C. (2015). Visualizing and assessing hypotheses for marine archaeology in a vr cave environment. *Journal on Computing and Cultural Heritage (JOCCH)*, 8(2):10.

Lane, H. C., Hays, M. J., Core, M. G., and Auerbach, D. (2013). Learning intercultural communication skills with virtual humans: Feedback and fidelity. *Journal of Educational Psychology*, 105(4):1026.

Makransky, G., Terkildsen, T. S., and Mayer, R. E. (2017). Adding immersive virtual reality to a science lab simulation causes more presence but less learning. *Learning and Instruction*.

Matsumoto, D. and Hwang, H. C. (2013). Assessing cross-cultural competence: A review of available tests. *Journal of cross-cultural psychology*, 44(6):849–873.

Merriam-Webster Online (2017). Merriam-Webster Online Dictionary.

Tackett, J. (2016). *Using a 3D immersive environment to study signal flow in music technology*. PhD thesis, Colorado Technical University.

Tasdemir, S. A. and Prasolova-Førland, E. (2014). Visualizing afghan culture in a virtual village for training cultural awareness in military settings. In *Information Visualisation (IV), 2014 18th International Conference on*, pages 256–261. IEEE.

Van Dyne, L., Ang, S., Ng, K. Y., Rockstuhl, T., Tan, M. L., and Koh, C. (2012). Sub-dimensions of the four factor model of cultural intelligence: Expanding the conceptualization and measurement of cultural intelligence. *Social and personality psychology compass*, 6(4):295–313.

Webster, R. (2016). Declarative knowledge acquisition in immersive virtual learning environments. *Interactive Learning Environments*, 24(6):1319–1333.

Wray, R., Lane, H. C., Stensrud, B., Core, M., Hamel, L., and Forbell, E. (2009). Pedagogical experience manipulation for cultural learning. In *Proceedings of the 2nd Workshop on Culturally Aware Tutoring Systems at the 14th International Conference on Artificial Intelligence in Education*, pages 35–44.

Yee, N. (2006). The psychology of mmorpgs: Emotional investment, motivations, relationship formation, and problematic usage. *Avatars at work and play: Collaboration and interaction in shared virtual environments*, 34:187–207.