System Usability Scale (SUS): Oculus Rift® DK2 and Samsung Gear VR®

Conference Paper · June 2017

DOI: 10.18260/1-2--28899

2 authors, including:

Rustin Webster
Purdue University

Paper ID #17819

System Usability Scale (SUS): Oculus Rift® DK2 and Samsung Gear VR®

Dr. Rustin Webster, Purdue University, New Albany

Dr. Rustin Webster is an assistant professor at Purdue University. He teaches within the Purdue Polytechnic Institute and the department of engineering technology. He specializes in mechanical engineering and computer graphics technology. Prior to joining Purdue, Dr. Webster worked in the Department of Defense field as an engineer, project manager, and researcher. His specialization was in mechanical design, research and development, and business development. He studied at Murray State University and the University of Alabama at Birmingham where his research was on immersive virtual learning environments for educational training purposes. Furthermore, Dr. Webster has received various professional certifications from the American Society of Mechanical Engineers, SolidWorks Corporation, the Project Management Institute, and NACE International.

Prof. Joseph F Dues Jr., Purdue University

System Usability Scale (SUS): Oculus Rift DK2 and Samsung Gear VR

Abstract:

This study investigated the broad usability of two different virtual reality (VR) systems, independent of each other. This research is hopefully the beginning of a series of studies to be conducted assessing the usability of various low-cost commercially available VR platforms. Data gathered will be used by stakeholders and decision makers to aid in the purchasing of VR hardware for academic classroom use. The ultimate goal is to continue studying the interaction effect between routine classroom instructor-led teaching (i.e. lecture-based multimedia instruction) and immersive VR teaching (i.e. VR-based multimedia instruction) in terms of learning. The experimental study used a convenience sample from a freshman course (two sections) at a land-grant university. Observations include a general overall excitement by participants to use VR no matter which system offered. This study has quantified the usability of the systems, which were created with the Oculus Rift DK2 and Samsung Gear VR at the core.

Introduction

There is much excitement about VR and its future in a number of markets and industries (Webster, 2015). However, early adopters of VR, as in the 80s and 90s, must be getting a sense of déjà vu. Headlines are proclaiming VR's killer application as social and gaming (Manly, 2015, Smith, 2015, Volpe, 2015). This is much different from the proclamations made towards the end of the last century when the focus was towards education and training as being the killer app (Stone, 2002). It is now 2016 and it is safe to say that VR has not been widely accepted into the classroom. Conversely, it is probably safer to say that VR has a higher presence in the home than educational institutions (Feltham, 2016, Hayden, 2015).

It is easy to see that the target consumer base for VR has most definitely shifted. No longer are the manufacturers primarily targeting large research institutions or government-funded agencies for scientific research purposes, but instead put the majority of their efforts towards a generation of gamers and multi-media enthusiasts. By pricing the products at a level that is now affordable for the masses, interest is growing rapidly. As products, such as the Oculus Rift, Samsung Gear VR, and HTC Vive enter the consumer market, the diffusion of VR technology and adoption rate will only increase.

One issue likely occur is that institutions of higher education will not be ready, willing, and/or able to fully welcome this new technology into the classroom. This will most likely happen due to a combination of deep academic traditions, budgetary issues, and/or a lack of skilled faculty and staff. This will be problematic as the next generation of college students will grow up with and become comfortable with VR technology while expecting the use, acceptance, and/or at least the visibility of it at their place of study. Even today, as mobile smart phones have become an integral part of our lives, some instructors deny or limit their use or even visibility in the classroom. Chances are that classroom acceptance of VR will be similar.

Purdue Polytechnic

Purdue Polytechnic, which is one of Purdue University's 10 colleges, is a transformational college unbounded by tradition (Purdue Polytechnic Institute, 2015). The transformation efforts that started in 2013 and continue today offer extraordinary opportunities to students and faculty and touch all parts of the college, including curricula, teaching methods and learning spaces. The breadth and depth of the transformation are enormous and are aimed at the following:

- Producing more graduates who are not only more capable of meeting the evolving needs of industries and communities, but who have a thirst for life-long learning and recognize the opportunities and challenges that technology brings society (Purdue Polytechnic Institute, 2015).
- Creating a learning environment that is more student-centered with ground-breaking teaching/learning techniques, includes competency-based and other innovative learning approaches giving students greater flexibility and autonomy in pursuing their personal interests, and fosters academic success across a broader and more diverse population (Purdue Polytechnic Institute, 2015).
- Expanding the college's state and global engagement and its research that are not only inspired by and more closely tied to the needs of industry and communities, but that also infuses innovation and entrepreneurship and integrates those skills into the college's learning environment (Purdue Polytechnic Institute, 2015).

Purdue Polytechnic has already begun efforts to prepare for classroom VR diffusion. Degree concentrations in game design, interactive visualization lab formations, and the hiring of trained faculty to champion the efforts have all occurred. Even with the drive and eagerness to make the student first in everything done there is still caution. Caution towards which technology is most effective for learning, easiest to integrate, lowest maintenance, most durable, safest, and highest usability to name just a few. No test, trial, and/or study can answer all those questions. Therefore, in an effort to educate administration and stakeholders in product selection, a series of studies is being conducted. The first of which is based around system usability between the Gear VR and Oculus Rift DK2.

Design Thinking in Technology

TECH 12000 – "Design Thinking in Technology", is a freshman level survey course designed to develop a students' perspective and enhance their skills in living and working in a technological society while introducing them to Purdue Polytechnic. Two sections of TECH 12000 were utilized by the researchers to recruit volunteers for this study.

Originally, the instructors, who are also the authors of this paper, planned to introduce the topic of VR to the class by digital presentation (e.g. PowerPoint). However, from experience and discussions they decided that for someone to fully understand and appreciate what current immersive VR is, they must experience it first-hand. This idea and the need to assist administration with classroom technology procurement are the foundational reasons for conducting the study.

Terminology

To ensure that there is consistent meaning between readers the following definitions are given:

- Head Mounted Display. Computer graphics equipment that is worn on the head which is a complex integration of electrical, optical, mechanical, and audio components that provide 2D or 3D viewing through either one (monoscopic) or two (stereoscopic) display feeds close to the user's eyes (Bowman, Kruijff, LaViola, & Poupyrev, 2005).

- Input Device. A physical device allowing communication from the user to the computer, such as a joystick, gamepad, or wand (Bowman et al., 2005).
- Interactive Simulation. Simulations over which the learner has some control, such as being able to slow down an animation or set input parameters and observe what happens (Mayer, 2010).
- Output Device. A physical device allowing communication from the computer to the user, such as a screen or projector (Bowman et al., 2005).
- Virtual Environment. Computer-generated representations of real or imaginary environments, experienced as three dimensional via a number of sensory channels. Objects within these environments are independent of the user and can display real world behaviour. The user has autonomous control - the freedom to navigate and interact with the objects. This interaction occurs in real-time and the users experience feelings of presence and/or involvement (D'Cruz, 1999).
- Virtual Reality. VR is a combination of high-end computing, human computer interfaces, graphics, sensor technology and networking which allows the user to become immersed in, interact, and experience in real time a three-dimensional (3D) artificial environment representing realistic or other situations (Mikropoulos & Strouboulis, 2004).

Some may also argue that desktop or mobile display systems are true and/or immersive VR. The authors disagree for the following reasons.

- The ability to block out the real world is very limited
- The digital content cannot be presented in life size
- The level of immersion is low or unattainable

System Usability Scale

The instrument chosen to measure usability was the System Usability Scale (SUS). The SUS has become an industry standard since its inception in 1986 with over 600 references (Sauro, 2011). Described simply as a reliable, low-cost usability scale that can be used for global assessments of systems usability (Brooke, 1996).

Defining usability in an absolute sense is not feasible; however, it can be defined with reference to specific contexts. Brooke (1996) states, it can be best summed up as a being a general quality of appropriateness to a purpose of any particular artifact. This leads to the conclusion that the intended users of the system must first be defined. Second, the intended tasks to be completed with the systems identified. Followed by stating the characteristics of the environments (e.g. physical, organizational, and social) in which the system will be used.

Pertaining specifically to VR, Blade and Padgett (2002) give the following definitions:

- Usability. The effectiveness, intuitiveness, and satisfaction with which specified users can achieve specified goals in particular environments, particularly interactive systems. Effectiveness is the accuracy and completeness of goals achieved in relation to resources expended. Intuitiveness is the learnability and memorability of using a system. Satisfaction is the comfort and acceptability of using a system.

- Usability evaluation. Any of a variety of techniques for measuring or comparing the ease of use of a computer system, including: usability inspection; user interface critiques; user testing of a wide variety of kinds; safety and stress testing; functional testing; and field testing.

The SUS provides a broad global view of subjective assessments of usability. It does not easily make comparisons of usability across different systems. This study is analyzing the usability of the two systems independently and the authors do not intend to try to make significant comparisons between the systems. However, it should be noted that the testing environments, assigned tasks, and population were generally comparable between system testing.

SUS was never intended to diagnose usability problems, thus not a diagnostic tool. So if low SUS scores are found it will be the researchers' responsibility to explore further, to identify the problems with the systems that caused the low scores.

Finally, The SUS is a 10-item questionnaire with a 5-response Likert scale. The Likert formatting ranged from strongly disagree to strongly agree. The 10-items are the following:

- I think that I would like to use this system frequently.
- I found the system unnecessarily complex.
- I thought the system was easy to use.
- I think that I would need the support of a technical person to be able to use this system.
- I found the various functions in this system were well integrated.
- I thought there was too much inconsistency in this system.
- I would imagine that most people would learn to use this system very quickly.
- I found the system very cumbersome to use.
- I felt very confident using the system.
- I needed to learn a lot of things before I could get going with this system.

Scoring the SUS is relatively easy and resulted in a single number representing a composite measure of the overall usability of the systems being studied. The scores of individual items are meaningless on their own. Calculating the SUS score is done by summing the score from each item, which has a range of 1 to 5 with 1 being strongly disagree and 5 being strongly agree. For odd numbered items (i.e. 1, 3, 5, 7, and 9), subtract 1 from the participants' response score. For even numbered items (i.e. 2, 4, 6, 8, 10) subtract the participants' response score from 5. This scales all values from 0 to 4 with 4 being the most positive response. Finally, after summing all individual scores multiply by 2.5 to obtain the overall value of SUS. This will convert the range of possible values to 0 to 100 (Brooke, 1996, Sauro, 2011).

Interpreting SUS scores is easy and straightforward. From Sauro (2011) an average SUS score is 68 and it is often recommended to normalize the score by converting it to a percentile rank (see Figure 1). Caution must also be made to not view a SUS score as a percentage. Above a 68 should be viewed as above average and below a 68 as below average. When communicating SUS scores to stakeholders, and especially those who are unfamiliar with SUS, it's best to convert the original SUS score into a percentile so a 70% really means above average (Sauro, 2011).

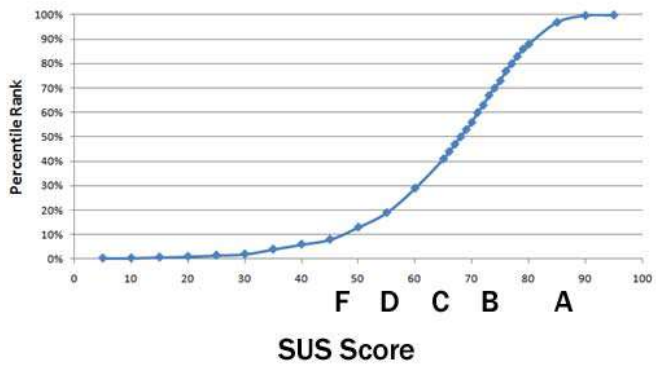

Figure 1. SUS Score Normalizing

Virtual Reality for Educating

Almost a decade and half old, (Salvendy, 2002) statement concerned with VR stills rings true.

> The field of virtual environments (VEs) emerged some 40 years ago as a very exotic, extremely expensive technology whose use was difficult to justify. The discipline has matured, and the cost of VE technology has decreased by over 100-fold, while computer speed has increased by over 1,000-fold, which makes it a very effective and viable technology to use in a broad spectrum of applications, from personnel training to task design. (p. XI)

The main target application for VR may have shifted towards gamers but education and training remain a popular choice (Greve, 2015). The VR affordances of interaction, immersion, and imagination (i.e. I3) along with entertainment, engagement, emotion provoking, and sensory extension (i.e. E4) all make it look like a promising tool for the classroom, teaching, and instruction. Sapp (2015), believes VR offers a new opportunity to close some of the pedagogical gaps that have appeared in the 21st century classroom learning. The following identified gaps stem from curriculum and content not being able to catch up to the rapid technological advancements of recent decades. VR might be able to address them all with its ability to offer a new type of discovery and organic exploration to encourage lifelong learning.

- Attention Gap. Attention spans have been decreasing over the past decade with the increase in external stimulation (Statistic Brain Research Institute, 2016). An exception to this is gaming, where it has shown that users are able to engage for extended periods.
- Time-Effective Use Gap. Opportunities for a learner to apply the knowledge and/or practice the skills that are being taught are limited.
- Pedagogy Gap. Modern pedagogy is not reflective of how the world looks and acts like in the 21st century and shows much resistance to change.

Of course, with any new technology entering the education world cost will be a driver. Until very recently, circa 2012, the price of VR hardware had been limiting classroom adoption. Now, Google offers its low fidelity Google Cardboard free to classrooms (Loney, 2016, Statt, 2015).

While full-scale classroom experiments with the Oculus Rift DK2 have also taken place (James, 2014). These two simple events are not alone. One can find a series of similar events, which can begin to paint a picture of how VR will be eventually integrated into school systems. It will begin slow and have minimal impact on pedagogy, schedules, budgets, etc., and often require outside contractors to implement. VR may possibly be in the form of an extracurricular club or activity or even a no credit course. It will be the students' intrinsic motivation for VR use and development that drives adoption.

The authors propose the following central themes concerned with classroom VR diffusion.

- Due to the lack of trained faculty and staff the majority will be afraid or unwilling to adopt
- Due to financial constraints the majority will not be allowed to participate
- Due to traditions in pedagogy and curriculum, administrations and accreditation agencies will not support, adopt, and/or allow

Method

The experimental study used a convenience sample from a freshman course (two sections) at a land-grant university. There were 26 participants with 21 being male. Their age range was 18-34. Participants took part in one of two VR experiences, each lasting approximately three to five minutes. Option A, a tethered version which utilized an Oculus Rift Development Kit 2 (DK2) (see Figure 2), wireless gamepad (see Figure 3) and headphones (Figure 4), and custom built desktop computer. Option B, a mobile version that utilized the Samsung Gear VR innovator edition (Figure 2), wireless headphones (Figure 4), and mobile phone (i.e. Samsung S6 Edge). Besides the differences due to hardware, the interactive simulation was held constant between the two groups; Titans of Space version 1.8 and version 1.1 respectively (see Figure 5 and Figure 6). This particular VR experience was chosen because it was available for both systems and it was known to have a low chance of inducing motion sickness. Outcomes include researcher's observations and the System Usability Scale (SUS), which was distributed and collected immediately after system use.

Volunteers were asked for at the beginning of each class. Once identified they were moved to a holding area. The researchers set up in similar offices, which were adjacent to each other. Each room contained one of the systems being investigated. The participants were randomly assigned to either option A or B. One by one, a student was asked to enter the office and take a seat. Next the author gave a brief description of each system and the expected tasks, which was to freely explore the hardware and interactive simulation for a predetermined time, which was approximately three to five minutes. It was emphasized that there was no right or wrong actions and questioning could and would happen after the testing time. Before placing the HMDs on the participants' head the authors ensured that the interactive simulation was at the start screen (see Figure 5). After testing and any Q&A, participants used their own mobile devices to scan a QR code provided by the researchers, which delivered an electronic version of the SUS (see Figure 7). Questions needed for descriptive statistics were asked prior to the 10 SUS items (see Figure 8 and see Figure 9).

Figure 2. Visual Device

Figure 3. Haptic System Control Device

Figure 4. Audio Device

Figure 5. Start Screen

Figure 6. Egocentric View of Interactive Simulation

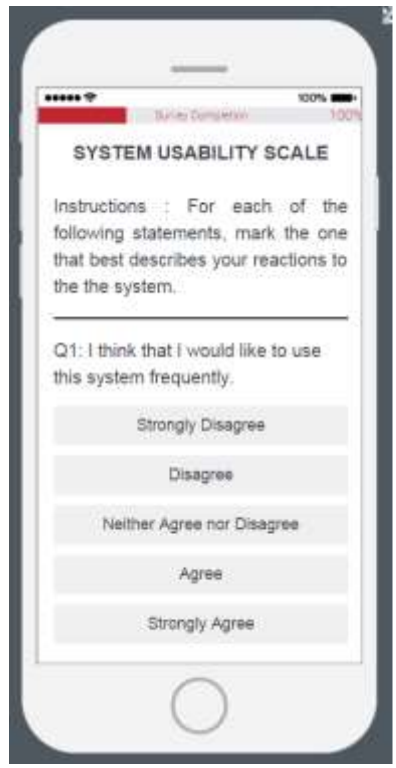

Figure 7. Mobile Phone SUS Screen Shot

Figure 8. Mobile Phone Questions

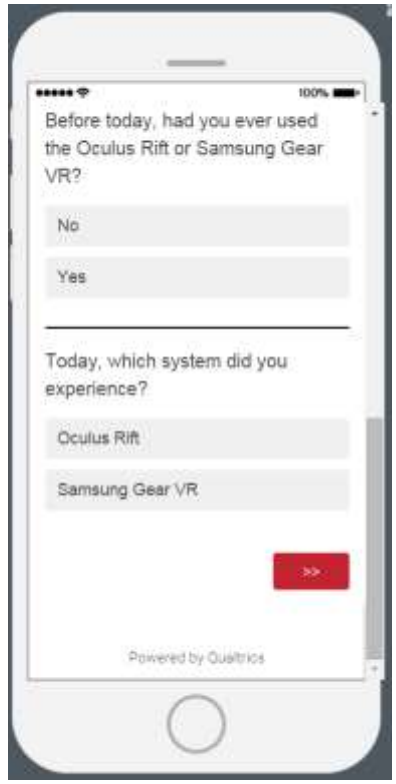

Figure 9. Mobile Phone Questions Cont.

Results

The results show a high mean SUS score across all participants at 82.8 (SD = 4.95). Option A, n = 14 (i.e. Oculus Rift DK2) had a SUS score of 82.9 (SD = 5.22) and option B, n= 12 (i.e. Gear VR) had a SUS score of 82.7 (SD = 4.85). Only one participant reported prior use of the Oculus Rift and/or Gear VR.

Students showed a general overall excitement to participate no matter which system they were assigned too. This is not surprising given the current surge of VR products entering the consumer market (Webster, 2015). The following outcomes were also compiled immediately after conducting the study and both authors support the individual observations.

- Observations from Option A and B participants
    - Some students needed and/or wanted instructions, others just jumped in and figured the interface out on their own.
    - During the experience, some students sat very still while others spun around completely and craned their neck in all directions.
    - Personal hygiene is a concern – sharing headsets and headphones.
    - Many of the students asked for additional time and different VR experiences.
    - Some students expressed desires for a more active experience, such as driving or flying.

    - A few participants who wore prescription glasses seemed slightly frustrated when they discovered the difficulties of wearing them with the HMDs.
    - Students verbally expressed after that a digital presentation on VR would have been less effective and informational.
- Observations from only A participants
    - The majority of the students expressed interest in the headphones, which were Bluetooth and bone conductive.
- Observations from only B participants
    - Some students struggled to find the touchpad on the Gear VR – to the point where we touched their hand to show them the location.

Discussion

It is important to keep in mind that the two systems are being investigated independent of each other. While both systems displayed above average SUS scores there cannot be any conclusions drawn on which system is better. The fact is there are other variables that must be taken into consideration before selection, which were not captured by the SUS.

First, the Gear VR allows for a higher degree of portability due to the untethered (i.e. wireless) design. On the other hand, the Rift allows for more demanding interactive simulation due to being powered and controlled by a PC versus a mobile phone. The Rift also allows for a higher degree of immersion through additional tracking. Both units can accommodate rotational (i.e. yaw, pitch, and roll) tracking of the head while only the Rift comes with the capability of positional tracking (i.e. X, Y, Z translation) of the head. A comparison of system specification is shown in Table 1.

Table 1. System Specification Comparison.

Name	Oculus Rift DK2	Samsung Gear VR / S6 Edge
Field of View (FOV)	100°	96°
Display resolution[1]	960 x 1080	1280 x 1440
Display size	5.7”	5.7”
Display type	AMOLED	AMOLED
Refresh rate	60Hz	75Hz
Latency	<20ms	<20ms
Cost[2]	$350	$200[3]
Physical UI[4]	External	External/Internal

Notes. [1]Display resolution per eye, [2]at initial launch, [3]does not include the price for the phone, [4]gamepad/touchpad

The above average SUS scores were of no surprise. The VR hardware of today is polished, user friendly, and highly exciting. However, the systems tested are already obsolete so follow on testing is needed and planned for the latest release of the Rift (circa 2016) and future releases of the Gear VR. To give administrators optimal guidance in product selection, other factors must also be investigated, such as durability, users' satisfaction, hygiene, availability, safety, etc.

Never before has the cost of VR hardware been this low. However, imagine a classroom of 20, 30, or even 40 students each needing a HMD and a computer capable of running the VR experience/lesson. The majority of schools do not have the budgets to make this happen, thus immersive VR, such as the systems investigated in this study, restrict scalability. The reality remains that current offerings are for individual use and thus individual learning.

As college professors, the authors' ultimate goal is to be able to someday replace certain lessons containing passive learning with active learning. In other word, replace routine classroom instructor-led teaching (i.e. lecture-based multimedia instruction) with immersive VR teaching (i.e. VR-based multimedia instruction). There is hope that costs will continue to decline with diffusion and acceptance, and immersive VR will develop into a viable educational tool. Currently, the most realistic and affordable VR option for simultaneous student learning in the classroom is Google Cardboard.

The Google Expeditions Pioneer Program, which includes Cardboard, is currently being beta tested in K-12 schools. It takes students on immersive virtual field trips via a mobile app, all while under the teachers' control. There are currently over 100 available expeditions, consisting mainly of historical, theological, cultural, artistic, or archaeological locations and events. Feedback has been largely positive for this disruptive technology. For example, instead of reading about the ocean floor in a textbook, students are now able to visualize full-scale panorama images and videos. However, what about college students, specifically engineering students. The ocean floor or the Natural History Museum are not commonly found in engineering curriculums or daily lessons. But wouldn't it be impactful if students could visualize the inside of an engine as it operated, follow along the assembly process of their favorite automobile, or learn about cradle to grave design from industry leaders? The authors' plan to investigate the immersion effect of Cardboard versus the Rift and/or Gear VR. If shown to provide comparable levels of presence/immersion, Cardboard may prove to be a worthy system for college classrooms. The manufacturing costs and the ability to utilize the students' mobile phones are cost savers that just cannot be ignored.

Conclusion

To summarize, Purdue Polytechnic is unbound by tradition and the administration expect teachers to implement as many modernized teaching strategies and tools as possible. All in hopes of providing instruction that is better aligned with 21st century students. Students are now part of digital and global economies compared to the analog and national economies of their parents. Traditional passive based lectures with PowerPoint have proved to be useful, effective, and efficient, just like the educational technology before it, such as the radio and overhead projectors. However, it too will be replaced someday with the next revolutionary teaching tool. Is VR that tool? Decades ago, many predicted it so; however, it has taken until now to be able to attempt the required full scale testing. The tools needed to answer the above question are rapidly becoming available and there is no better setting than Purdue Polytechnic to test the theory.

References

Blade, R. A., & Padgett, M. L. (2002). Virtual environments standards and terminology. In K. M. Stanney (Ed.), *Handbook of virtual environments: Design, implementation, and applications* (pp. 15-27). Mahwah, NJ: Lawrence Erlbaum Associates.

Bowman, D. A., Kruijff, E., LaViola, J. J., & Poupyrev, I. (2005). *3D User Interfaces: Theory and Practice*. Boston, MA: Pearson Education, Inc.

Brooke, J. (1996). A "Quick And Dirty" Usability Scale. In P. W. Jordan, B. Thomas, B. A. Weerdmeester & I. L. McClelland (Eds.), *Usability Evaluation in Industry* (pp. 189-194). London, UK: Taylor & Francis.

D'Cruz, M. (1999). *Structured Evaluation of Training in Virtual Environments* (Unpublished Ph.D. thesis). University of Nottingham, Nottingham, United Kingdom.

Feltham, J. (2016). *Oculus Rift Day One Stock Sells Out In 14 Minutes*. Retrieved from: http://vrfocus.com/archives/27501/oculus-rift-day-one-stock-sells-out-in-14-minutes/

Greve, B. (2015). *Using the Oculus Rift to revolutionize Education*. Retrieved from: https://unimersiv.com/post/using-the-oculus-rift-to-revolutionize-education/

Hayden, S. (2015). *Oculus Reveals More than 175,000 Rift Development Kits Sold*. Retrieved from: http://www.roadtovr.com/oculus-reveals-175000-rift-development-kits-sold/

James, P. (2014). *This is the Beginning of VR Education, and It Will Only Get Better*. Retrieved from: http://www.roadtovr.com/world-of-comenius-virtual-reality-education-biology-lesson-leap-motion-oculus-rift-dk2/

Loney, H. (2016). *Upper Grand students tour Arctic tundra, underwater ecosystems through Google's virtual reality journeys*. Retrieved from: http://www.ugdsb.on.ca/news_article.aspx?id=63559&blogid=32405

Manly, L. (2015). *A Virtual Reality Revolution, Coming to a Headset Near You*. Retrieved from: http://www.nytimes.com/2015/11/22/arts/a-virtual-reality-revolution-coming-to-a-headset-near-you.html

Mayer, R. E. (2010). Learning with Technology. In H. Dumont, I. David & F. Benavides (Eds.), *The nature of learning: Using research to inspire practice* (pp. 179-198). OECD Publishing.

Mikropoulos, T. A., & Strouboulis, V. (2004). Factors That Influence Presence in Educational Virtual Environments. *CyberPsychology & Behavior 7*(5), 582-591. doi: 10.1089/1094931042403109

Purdue Polytechnic Institute. (2015). *Transformation Implementation Plan.* Retrieved from https://polytechnic.purdue.edu/Transformation

Salvendy, G. (2002). Series foreword. In K. M. Stanney (Ed.), *Handbook of virtual environments: Design, implementation, and applications* (pp. xi-xii). Mahwah, NJ: Lawrence Erlbaum Associates.

Sapp, C. (2015). *How Virtual Reality Can Close Learning Gaps in Your Classroom*. Retrieved from: https://www.edsurge.com/news/2015-09-07-how-virtual-reality-can-close-learning-gaps-in-your-classroom

Sauro, J. (2011). *Measuring Usability With The System Usability Scale (SUS)*. Retrieved from: http://www.measuringu.com/sus.php

Smith, D. (2015). *Why Virtual Reality's Killer App Will Be Social*. Retrieved from: http://www.businessinsider.com/virtual-reality-killer-app-will-be-social-2015-7

Statistic Brain Research Institute (2016). *Attention Span Statistics*. Retrieved from: http://www.statisticbrain.com/attention-span-statistics/

Statt, N. (2015). *Google is offering its virtual reality classroom system to schools for free*. Retrieved from: http://www.theverge.com/2015/9/28/9409571/google-expeditions-virtual-reality-field-trips

Stone, R. J. (2002). Applications of virtual environments: An overview. In K. M. Stanney (Ed.), *Handbook of virtual environments: Design, implementation, and applications* (pp. 827-856). Mahwah, NJ: Lawrence Erlbaum Associates.

Volpe, J. (2015). *Epic Games' New Shooter Is Virtual Reality's Killer Gaming App*. Retrieved from: http://www.engadget.com/2015/09/25/epic-games-new-shooter-is-virtual-reality-killer-gaming-app/

Webster, R. (2015). Turn-Key Solutions: Virtual Reality. Paper presented at 35th Computers and Information in Engineering Conference, Boston, MA, 2-5 August (pp. 9). New York, NY: American Society of Mechanical Engineers. doi: 10.1115/DETC2015-46174