



Available online at <http://www.ijcrs.com>

International Journal of Current Research in Life Sciences
Vol. 08, No. 10, pp.3248-3253, October, 2019



ISSN: 2319-9490

RESEARCH ARTICLE

UNDERSTANDING VIRTUAL REALITY TOURS: A USER EXPERIENCE STUDY WITH THE PRINCESS NORAH UNIVERSITY

Mona Alenazi and *Fatih Demir

101G Gabel Hall Stadium Dr. Dekalb, IL 60115, US

Received 27th August, 2019; Accepted 14th September, 2019; Published 30th October, 2019

ABSTRACT

The virtual tour is defined as a simulation of a real place that often includes multimedia such as images, text, sound effects, and video clips. These features can help a learner navigate through the digital platform to get the information he/she needs. User Experience plays an important role in the success of virtual tours because the platforms should deliver the services for user satisfaction. The virtual tour website should be user –friendly. Users should be able to navigate through the website to locate the services or the goods they are looking for. The purpose of this project was to assess the success of a virtual tour of Princess Norah University in Saudi Arabia. This study evaluates the experiences of the visitors who have taken the virtual tour of the Princess Norah University website. The research results showed that the virtual tour was uninteresting and lacked view options. The graphic design needed improvements in virtual tour visibility because some of the user demands are missing such as images of campus buildings and some content features were not available. General design recommendations are made in terms of adding user- generated content to foster collaboration in a virtual community.

Key words: Virtual Tour, Princess Norah University, Needs Analysis, Usability, User Experience.

Copyright © 2018, Mona Alenazi and Fatih Demir. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Citation: Mona Alenazi and Fatih Demir. "Understanding Virtual Reality Tours: A User Experience Study with the Princess Norah University" *International Journal of Current Research in Life Sciences*, 8, (10), 3248-3253.

INTRODUCTION

Designers utilize virtual tour technology to provide the experience of real-time interactivity, simulation of real-life scenarios, and improvement of spatial awareness among users, which would attract customers to the project and increase the popularity. Virtual tours are commonly used in education and marketing to present the user with an experience that goes beyond still images. Also, it can be used as an educational practice in order to improve students' involvement and provide variety to the classroom practices. The virtual tour also provides visitors with the ability to explore the campus by using tablets or smart phones. Princess Norah University of Saudi Arabia hosts virtual campus tours on the web site to offer a virtualized immersive campus tour for its students and to attract prospective students. It is supported by texts and other multimedia that can be presented electronically via the web in a way that can be displayed and is related to the way of touring and visiting a specific place in the content of the tour (Nix, R. K., & Australia, W., 1999). An earlier study performed by Spicer & Stratford (2001) revealed that students rated virtual tours as a viable practice, yet, they insisted that it cannot replace real-life field trips.

As a result, field tours were used as an additional tool for teaching that had a very rigid structure. In other words, the students simply used their laptops to scroll through the virtual tour of a museum or a physical location, while the teachers provided new information. Technological advancement provided educators with numerous new tools and practices that can help them to improve classroom experience and engage the students in the lessons more effectively. Virtual tours are one of the newest tools used by teachers in the classroom as part of a specific practice. Overall, virtual tours were developed to show the physical space to the users who did not have access to it. This technology became useful for observing both indoors and outdoors physical spaces in remote locations. For example, Google Maps uses this technology to provide users with street views and locations. Virtual tours can immerse the user experience by providing a balance between comfort, realism, and meaningful experience. Very often virtual tours are used to provide aesthetically pleasing experience that is also meaningful for the users. Immersion of virtual tours is achieved by developing fully stimulating environment that includes a large spectrum of sensations.

The History of the Virtual Tour: The first use of virtual tours was back in 1994 (Higgins, 1996). One of the first hosts for a virtual tour was Great Britain's Queen Elizabeth II, as she officially opened the Visitor Center at Dudley Castle in Great Britain.

*Corresponding author: **Fatih Demir**
101G Gabel Hall Stadium Dr. Dekalb, IL 60115, US

Virtual tours have since become an effective means of using the Internet to present archaeological and tourist sites, museums, and for educational use (Higgins, Main Lang, 1996). Lee (2004) found that since the virtual tour's inception, 54 million Americans have used the Internet to take part in them, and more than 1 million teachers, parents, and learners of all ages have used them. These tours include museums, tourist sites, colleges, and schools. Increasing Internet use has led to the proliferation of virtual tours, encouraging their creators to create even better experiences for user. The virtual tour is a tool that is useful for all viewers in higher education institutions. It can provide detailed and in-depth pictures of the campus and accompanying textual descriptions via computer while providing additional information about the campus itself. Virtual tours are a strong technological innovation emerging from the Internet assisting many educators and students (Lee, 2004). Initially, virtual tours were used in the higher education institutions as a sedentary practice that involved a laptop and they were used in teaching history or geography.

However, this practice eventually evolved, and educators developed new ways of implementing field tours in their lessons. One of the new ways of applying this practice in the classroom is virtual field trips (VFTs). According to the research conducted by Norris et al. (2015), VFTs are new physically active lessons that include both the curriculum content and movement by utilizing interactive whiteboards. During VFTs, students combined the use of virtual reality gadgets and physical activity. It was discovered that educators perceived VFTs as a flexible and adaptable teaching practice, which provides inclusive learning across different subjects (Norris et al., 2015). Students enjoy new practices, especially the ones that involve innovative gadgets. VFTs might help the students to increase their physical activity level during the classroom activities and learn new information through participating in the interactive experience. One of the simplest ways of using VFT is to supplement a lesson with this practice by allowing students to observe virtual tours through the screens. Virtual tours can be applied in the classroom in order to teach students how to perceive physical space, and how to use virtual modeling and interaction with the environment. For example, Hehr (2014) used VFT as the main tool in teaching local history, which recognized that the students improved their skills in connectivity and modeling while developing a mini virtual tour based on Iowa history. The study allowed students to create VFT elements that covered local history (Hehr, 2014). Overall, virtual tours can help teachers to improve their classroom routine, as VFT is a novice practice that will be interesting for students. It will be able to teach students using modern technologies and combining virtual and physical spaces. VFT is an effective practice that can help to target low engagement of students.

Meaning of a Campus Tour: Campus tours are one of the best ways to recruit potential students. According to Richard A. Hesel (2014) of the Art & Science Group, LLC, "the campus visit is the single most influential source of information for students" (p.1). As the competition between universities to be the best and brightest intensifies, universities are developing innovative campus tours to attract students. In a survey conducted by Art & Science Group, LLC, a consulting firm for higher education, the survey shows that among the 500 students surveyed, 94% visited the university campuses and 65% indicated that their visit to the campus influenced their decision to apply.

Many universities are creating unique experiences for prospective students by thinking outside the box when it comes to campus tours. Universities must realize that in order to remain competitive within the evolving landscape, they need to embrace technology through the adoption of virtual reality and enhanced reality (Mendolia, 2019). Throughout in Okerson's (2018) research study, he mentioned that the importance of the aesthetic appearance of the campus, the amount of construction, were, again and again, factors that influenced a potential university student's visit and the overall impression of an institution. Another research study (Hodges & Barbuto, 2002) that examines the decisions of the college selection team confirms the importance of the campus tour in conjunction with the faculty website and communication with faculty members and students. Hesel (2004), reported the importance of the campus tour data. What we learned is that nearly all students—of every academic ability and income level—are visiting college campuses (and most reported visiting their first and second-choice schools). The findings reveal that the hospitable nature (vibe) of the community and the friendliness of the people whom the students encountered during these visits had a significant positive impact on their interest in a school. Moreover, seeing facilities of interest to them, talking to professors, and attending classes made students more interested in the institution that ultimately became their first-choice school (Okerson, 2016.p 48).

The campus visit is defined as "any visit, whether formal or informal, to a college campus, which may include an information session, formal campus tour, sitting in on a class, overnight visit, or admitted student program" (Okerson, 2016.p 10). In general, the student's reaction to the campus and its appearance, and based on a series of interactions that occurred during the campus visit, have influenced the decision-making process. This virtual tour/visit allows the student to decide whether he feels comfortable on campus. The campus tour allows students and employees to guide themselves around the campus, visit the library, dining facilities, classrooms, accommodation and other holy sites on campus. (Okerson, 2016). These visits help the students to take a decision about their progress or non-submission to the college, and ultimately whether they will attend or not. A three-year longitudinal study at a large public university with 23,187 students concluded that the students who visit a particular school prior to submission are likely to make a decision to go to the college more than twice the number of students who did not visit before applying. Gregory (2014) argued that it is essential for each institution to have a strong digital presence that is designed for the students to have an experience of visiting the campus closely. This digital presence also raises interest in students to do an actual visit to the campus. Many colleges and universities offer a variety of "alternative" tour options: self-guided, acoustic and virtual guided tours, which is an excellent addition to students and families unable to visit the campus (Okerson, 2016). In addition, the design team needs to consider that "all product design should begin with a thorough review of potential users" (Nielsen, 1993, p. 46) to define the usability of the system. This evaluation process commenced with the analysis and impressions of the user because "usability is both a philosophy to be followed during the design phase of the product development and a property of the final product to be evaluated, typically referred to as usability testing" (Peterson, 2007, p. 338).

Significance of the Project: Princess Norah bent Abdulrahman University is in Riyadh City and is considered the first university established exclusively for women in the Kingdom of Saudi Arabia. It was founded in 2008 and is the largest university for women in the world. Improving user experience of the virtual tour will allow women who live far from Riyadh to view the university, without first having to travel there. It will also give improved virtual access to the university for researchers and educators interested in viewing parts of it before applying for employment or research opportunities. In Saudi Arabia, there are several travel restrictions for women. These include requirements that women travel with a male figure, as women historically have been restricted from driving. These policies can impact women's abilities to visit Princess Norah University prior to enrolling. The virtual tour, however, allows women to view the physical aspects of the university via technology. This makes the virtual tour important to prospective students and helps combat the travel restrictions Saudi women face in pursuit of higher education. The virtual tour will help students interested in attending the University to see the campus before enrolling, and they don't have to travel in-person to the campus in order to see it. Also, students who don't live in Saudi Arabia will be able to view the campus without traveling there. International students would appreciate a faster virtual tour, more images of campus life, a view of the library, instead of an in-person visit. Lastly, researchers and faculty interested in studying or teaching at Princess Norah University will be able to view the campus from all around the world.

The purpose of this study is to evaluate the user experience of the virtual tour application hosted on the Princess Norah University website. The goal of UX research is to analyze user needs, expectations as well as design problems for better product design (Demir, et al, 2017). The project goals are (1) to evaluate how the virtual tour fits to users' needs, (2) how users interact with the virtual tour, and (3) to identify any obstacles that users encounter when they click and view the virtual tour.

Research Questions:

- How do users interact with the virtual campus tour at www.pnu.edu.sa?
- What is the effectiveness, efficiency and user satisfaction scores of the prospective students and employees with the www.pnu.edu.sa website?
- What is the effectiveness, efficiency and user satisfaction scores of the prospective students and employees with the virtual tour?

MATERIALS AND METHODS

A mixed method deployed for this research comprised structured interview, observation, and survey. Six participants were interviewed; two who plan to study at the university, one who will apply for employment, and three who plan to visit the university. A usability study with 7 predefined tasks was designed. The users' subjective satisfaction levels are measured utilizing System Usability Scale (SUS) survey which is a UX industry standard Likert type 10-items survey, widely used in UX research; proven to be valid and reliable with thousands of researchers to determine the level of user satisfaction (Demir & Hernandez, 2018). The SUS scale survey was presented to measure the self-satisfaction of participants on the virtual tour.

A questionnaire was created to determine demographics of the participants. The study is designed in four stages: (a) determination of demographics. (b) completing the pre-defined tasks; (c) the self-satisfaction of web services through the SUS survey, and (d) quasi-structured interview after the task to obtain feedback about the participant experience.

The research was conducted from October to December 2017 with the participation of 6 users. Pre-defined task stage is observed to measure efficiency and effectiveness rates. A stopwatch was used to monitor the completion rates for each task. An Excel worksheet was filled out for successful completion (effectiveness) and time to complete a task (efficiency) rates. In addition, participants' interaction with a screen recorder program was recorded for further analysis.

Pre-Defined Tasks

The participants were asked to complete the tasks one at a time on Princess Nora University website virtual tour as follows:

- Find Princess Nora University website.
- You would like to learn more about Nora University. Find a virtual tour to discover NU.
- You are wondering about the Library. Find the images of the University library.
- You want to see students' pictures within the campus environment. How would you do this?
- Inform your friends by emailing about virtual tour of the Nora University.
- Name five facilities at Princess Norah University.
- Fast forward to your favorite image within the virtual tour and document your favorite image on the questionnaire.

RESULTS

Two male and four female international students participated in this study. The participants were selected from various educational backgrounds and fields of study; one person was from the biology program, two were from the music program, and three were from the instructional technology program. Two participants are between the ages of 20 and 29, and four are between the ages of 30 and 39. Two participants are from China, and four are from Saudi Arabia. All six participants were interviewed; two of which plan to study at the university, one who wants to apply for employment, and three who plan to visit the university. Regarding the level of expertise in technology, two of them identified themselves as beginners, two were intermediate, and the other two were advanced. All participants reported that they had some experience with the technology as the users of smartphones, tablets, laptops, and educational websites.

Effectiveness: Success Scores on task completion: Effectiveness of a product is assessed through participants' ability to repeatedly accomplish tasks successfully (Demir, Karakaya, & Tosun, 2012). Guinea, Chen (2006) state that the users have different perceptions on the effective use of a multimedia application based on their personal characteristics. Participants in this study were of different nationalities, ages, academic backgrounds, and majors. In this study, seven tasks were defined and conducted by six participants, which means

70 tasks in total were completed. As Table 1 shows, only seven of the 70 tasks failed; only two tasks were completed by all participants; that is a 57.14% success rate. The mean of the task completion scores was 57.14. The two tasks that are completed successfully by all participants include locating the Princess Norah University website and determining the virtual tour respectively on the web site. One participant experienced technical issues caused by the poor Internet connection. No participant completed Task 4 which requires that participants locate students' images within the virtual tour.

Efficiency: Task completion time: Efficiency results revealed that the participants, as first-time users of the virtual tour on the Princess Norah University website, completed all the tasks in an average of 16.46 minutes. Task completion time per task ranged from 2.9 minutes to 7.09 minutes. Participants took 1.27 minutes on average to become familiar with the system. The longest a participant took to complete Task 1 is 1 minute and 27 seconds and 1 minute and 25 seconds for Task 2. Task 4 took the longest to complete at in an average of 7 minutes and 09 seconds, at which time the participants seem to lose interest.

Think Aloud Interview Results: The participants thought music or audio should be added to the virtual tour, and that there should be more images of the library, the University Café, and inside of the library building.

The three main concerns were:

- User inability to make images larger or smaller within the virtual tour.
- The slowness in playing virtual tour caused uninterested with the tour.
- Poor visibility of the virtual tour link on the website.
- Missing map of the campus.

Most of the participants found the virtual tour unnecessarily complex, three participants felt they needed to know more information before completing the virtual tour, three participants felt they would need technical support to complete the tour, and all participants expressed that there was too much inconsistency in the tour. All of them found the campus visually and aesthetically appealing. They all agreed that no students were present in the images. In general, based on the table, learnability scores track higher than the usability scores and the original SUS score for a selection of 88 studies.

User Satisfaction Survey Results: For this usability test, we obtained a user satisfaction rating using the standard SUS survey. The overall SUS score is indicated 53.8 (see Table 3) which is way below than the industry accepted average score of 65 (Demir, 2011). Adopting Sauro and Lewis' (2012) curved grading scale (also provided in Lah& Lewis, 2016) (see Table 4), the satisfaction scores can be interpreted as follows: virtual tour SUS score averaged 53.8. The scale of the virtual tour indicate that participants' satisfaction was at a D level and there was much room for improvement.

DISCUSSION

The research results showed that the NU virtual tour needs improvement, especially given the growth in higher education in Saudi Arabia, the increase in international mobility, and the ability of more Saudi women to pursue higher education.

As it stands today, the NU virtual tour is not an effective method for displaying the campus to users because it is too slow and does not allow for adequate user interaction. However, the images displayed during the tour are aesthetically pleasing to users. Most of the participants found the images "beautiful". Participants had a great interest in seeing the library, the University Café, and images of students and campus life. The NU virtual tour provides a virtual campus and allows users to obtain useful information such as building names, directories, university and statistical data, events scheduled to take place on campus, and area maps that focus on specific locations. Users can navigate through the 3D representation of the campus by adopting either a first- or third-person view and by selecting either a walk or flight exploration mode (Larmore, Knaus, Dascalu, & Harris, 2005). Negative feedback from the study participants suggested the NU virtual tour takes too long and does not include images of human beings which they indicated would make it more aesthetically pleasing. Also, the location of the NU virtual tour on the webpage makes it difficult for some people to locate. Additionally, participants could not find the map for the campus nor pinpoint a particular facility.

The results clearly show that the subjective satisfaction level with the NU virtual tour link on the website is at the F level, which is the worst possible result for a website. From these findings, it can be said that the NU virtual tour link on the NU website should be redesigned in a more user-centered way to meet the needs and expectations of the current and prospective students and employees. This helps to increase the satisfaction level and to provide expected service to the best practices for virtual tour design.

Limitations: The limitation of this study is to have small sample size. Although there is a good body of research indicating that five participants are enough to uncover almost 90% of UX related issues in a system (Demir, 2011; Nielsen, 2012) a larger sample size may have an impact in identifying better outcomes.

Conclusion

Choosing a college is a life-time experience for a student in multiple aspects. The social spaces on campus, such as student lounges, entertainment centers, cafes, or any other place where students gather might be crucial for a student before making a final decision as to whether or not they decide to attend a particular university. When a student decides to attend a university, he/she will be connected on campus for the next couple of years. Therefore, through self-exploration, Virtual Tours help prospects to get a sense of the life in the campus, facilities, and environment. This user experience research study is designed to determine the efficiency, effectiveness and satisfaction levels of the Princess Norah University of Saudi Arabia as well as its virtual tour service. A mixed-methods deployed including pre-defined tasks, satisfaction survey, and semi-structured interview. The poor design of the NU web site increases the time to complete the tasks, causes users to terminate, and ultimately decreases efficiency rates. The design problems also play a major role in negatively affecting the users. The research results indicate that the NU higher education institutions' web sites should be designed in a more user-friendly, user-centered and usable way to increase user satisfaction.

Table 1. System Effectiveness (Task Completion Note. 1 indicates success; 0 indicates failure)

Participants	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7	Total	Mean completion rate
P 1	1	1	1	0	1	1	0	5	71.4
P 2	1	1	0	0	0	1	1	4	57.14
P 3	1	1	0	0	1	1	0	4	57.14
P 4	1	1	1	0	0	1	1	5	71.4
P 5	1	1	0	0	0	1	0	3	42.85
P 6	1	1	1	0	1	0	0	4	57.14
Mean total score	6	6	3	0	3	5	2	3	57.14

Table 2. System Efficiency (Task Completion Time, mm:ss)

Participants	Task1	Task 2	Task 3	Task4	Task5	Task6	Task7	Total time
P1	1.3	1	1.24	7.38	2.2	1.35	3.4	13.79
P2	1.14	0.45	3.4	8.37	4.25	2.3	2.1	18.94
P3	0.38	1.26	4.25	6.54	1.24	1.14	3.43	15.24
P4	2.41	1	2.19	7.37	3.46	2.35	2.33	15.91
P5	1.38	1.23	4.35	6.45	3.32	2.12	4.23	19.08
P6	1.05	1.21	2.13	6.43	1.35	3.42	3.26	15.85
Average	1.27	1.25	2.9	7.09	2.63	2.11	3.125	16.46

Scales		
SUS	Usability	Learnability
53.8	44.8	89.6
60.0	46.9	112.5
57.5	56.3	62.5
42.5	37.5	62.5
47.5	34.4	100.0
65.0	53.1	112.5
50.0	40.6	87.5

Table 4. Curved grading score

Letter grade	Numerical score range
A+	84.1–100
A	80.8–84.0
A-	78.9–80.7
B+	77.2–78.8
B	74.1–77.1
B -	72.6–74.0
C +	71.1- 72.5
C	65.0 – 71.0
C-	62.7– 64.9
D	51.7– 62.6
F	0–51.6

The recommendations for further development of the product include

- Update the photos within the tour annually.
- Make the technology that displays the image faster.
- Use an animated tour guide to explain the facilities and images displayed in the tour.
- Create more opportunities for user interaction.
- Add photographs of campus life.
- Add a virtual map.
- Make the title of the facilities more visible.
- Have tabs at the top of the virtual tour page that invite users to interact with the website and learn more about the institution.
- Add still photos of each facility that the user can click on to view.
- Use simple but descriptive sentences.
- Have options for the user to enlarge the text.

REFERENCES

- Brown, R. 2006. Creating a Virtual Tour Design Guide for Museums with the Centre for Accessible Environments (*Doctoral dissertation, Worcester Polytechnic Institute*).
- Demir, F. & Hernandez, W.H. 2018. The More Complex the Less Success in Online Library Services, Issues, and Trends in Educational Technology, 6(2), 50-64.
- Demir, F. 2011. Technology Use in Community Policing: Usability Evaluation by Eye Tracking Method, Germany: LAP LAMBERT Academic Publishing.
- Demir, F., Ahmad, S., Callyam, P., Jiang, D., Huang R. & Jahnke, J. 2017. A next-generation augmented reality platform for mass casualty incidents (MCI). *Journal of Usability Studies*, 12(4), 193-214.
- Demir, F., Karakaya, M., & Tosun, H. 2012. Research methods in usability and interaction design: Evaluations and case studies (2nd ed.). Germany: Lambert Academic Publishing.
- Gregory, J. 2014. 10 ways students search college's today- and how to adapt: Understand how students choose a school and recalibrate your approach for recruitment success. *University Business*, 17. Retrieved from

- <http://www.universitybusiness.com/article/10-ways-students-search-collegetoday%E2%80%94and-how-adapt>
- Hehr, K. H. 2014. Virtual field trips as an educational and motivational strategy to teach Iowa history. *Graduate Theses and Dissertations*, 14178, 1-28.
- Higgins, T., Main, P., & Lang, J. (Eds.). 1996. Imaging the past: electronic imaging and computer graphics in museums and archaeology. London: British Museum.
- Kraljic, N. 2008. Interactive video virtual tours. In *12th central european seminar on computer graphics*. Split, Croatia.
- Larmore, R., Knaus, M., Dascalu, S., & Harris, F. C. 2005. Virtual environment for on-campus orientation. In *Collaborative Technologies and Systems, 2005*. Proceedings of the 2005 International Symposium on (pp. 259-266). IEEE.
- Law, E. L. C., Roto, V., Hassenzahl, M., Vermeeren, A. P., & Kort, J. 2009. Understanding, scoping and defining user experience: a survey approach. In *Proceedings of the SIGCHI conference on human factors in computing systems*(pp. 719-728). ACM.
- Lewis, J. R., & Sauro, J. 2009. The factor structure of the system usability scale. In *International conference on human centered design* (pp. 94-103). Springer, Berlin, Heidelberg.
- Mendolia-Moore, T. 2019. The College Path: A Virtual Tour.
- Nielsen, J. 1993. Usability engineering. San Diego, CA: Academic Press.
- Nielsen, J. 2012. *How Many Test Users in a Usability Study?* Retrieved from [https:// www.nngroup.com/articles/how-many-test-users/](https://www.nngroup.com/articles/how-many-test-users/)
- Nix, R. K., & Australia, W. 1999. A critical evaluation of science-related virtual field trips available on the World Wide Web. *Curtin University of Technology*.
- Norris, E., Shelton, N., Dunsmuir, S., Duke-Williams, O., & Stamatakis, E. 2015. Teacher and pupil perspectives on the use of Virtual Field Trips as physically active lessons. *BMC Research Notes*, 8, 719-728.
- Okerson, J. R. 2016. Beyond the campus tour: College choice and the campus visit.
- Peterson, A. 2007. Usability Theory, Practice, and Evaluation for Learning Objects. In Koohang and Harman (Eds.). Koohang, A. & Harman, K. Learning Objects: Theory, Praxis, Issues, and Trends. Santa Rosa, (p.337-370). California: Informing Science Press.
- Rainie, L. 2004. Virtual tours: 54 million Americans have used the Internet to take virtual tours. *Pew Internet and American Life Project*. Available from Pew Internet and American Life Project Web site, <http://www.pewinternet.org>.
- Robinson, L. 2009. Virtual Field Trips: The Pros and Cons of an Educational Innovation. *Computers in New Zealand Schools: Learning, Teaching, Technology*, 21(1), 1-17.
- Sauro, J. & Lewis, J. 2016. Quantifying the user experience: Practical statistics for user research. Amsterdam; Waltham, MA: Elsevier/Morgan Kaufmann.
- Spicer, J. I. & Stratford, J. 2001. Student perceptions of a virtual field trip to replace a real field trip. *Journal of Computer Assisted Learning*, 17(4), 345–354.
