Journal of Advanced Research in Applied Sciences and Engineering Technology 46, Issue 2 (2025) 178-187

Journal of Advanced Research in Applied Sciences and Engineering Technology

Journal homepage: https://semarakilmu.com.my/journals/index.php/applied_sciences_eng_tech/index
ISSN: 2462-1943

Virtual Simulation for Flight Emergency Water Landing: A Usability Assessment

Nur Farahin Mohd Johari[1], Norshahidatul Hasana Ishak[1], Hazrati Zaini[1,*], Minhalina Mohamad Zain[2]

[1] Universiti Teknologi MARA (UiTM) Cawangan Melaka, Kampus Jasin, 7730 Merlimau, Melaka, Malaysia
[2] Lembaga Hasil Dalam Negeri, Lingkaran Cyber Point Timur, 63000 Cyberjaya, Selangor, Malaysia

ARTICLE INFO

Article history:
Received 18 August 2023
Received in revised form 3 December 2023
Accepted 13 March 2024
Available online 9 June 2024

Keywords:
Virtual reality; Virtual simulation; Flight emergency simulation; Usability testing

ABSTRACT

Flight courses are necessary especially for individuals who are common with flights or frequently travel by flight such as pilots, cabin crews, and passengers. These courses commonly consist of a few modules such as safety and emergency modules which could occur at any time without expecting it. In relation to that, there are several types of emergency landings including force landing, precaution landing, and ditching. Ditching is a forced or precautionary landing on water, which rarely happens, especially in Malaysia. As frequent travellers discover repeated pre-flight safety briefings to be uninteresting and exhausting, a large portion of travellers stay inattentive during such briefings. Additionally, emergency situations can be a difficult condition to be imagined especially by any individual who has not experience it. Therefore, Virtual Reality (VR), a computer-generated environment, can be utilised to simulate a real-world environment. By using VR, we can exterminate the potential risks to the participants during training or real situations. Hence, this present study aimed to assess the usability of a semi-immersive VR simulation for flight emergency water landing, as well as to educate and raise awareness among fliers, particularly adult flight passengers, on how to handle the evacuation process in the event of a flight emergency water landing. We developed a semi-immersive 3D environment on flight emergency water landing simulation. The apps' usability was tested using System Usability Scale (SUS). The results and conclusions point to a positive outcome where 76.6% of the respondents agreed that this app is usable for emergency water landing simulation situations. However, this study uncovered key findings for future researchers to address; i) researchers should consider the technical aspects when using the semi-immersive VR, and ii) researchers should provide preventive measures to avoid or reduce the after effects of using additional VR devices.

1. Introduction

Flight safety courses are crucial for pilots, cabin crews, and passengers. As part of the responsibilities of cabin crews, they must thoroughly understand flight safety before briefing passengers in order to prepare them especially in responding promptly to emergency situations,

* *Corresponding author.*
E-mail address: hazrati_zaini@uitm.edu.my

https://doi.org/10.37934/araset.46.2.178187

increasing survival rates after aircraft accidents, and improving passengers' understanding of safety equipment and emergency procedures [1]. Additionally, cabin crews typically provide a pre-flight safety briefing before the flight departs, and every flight would include a safety card. However, for some frequent fliers, repeated briefings are uninteresting and boring [2]. To address this issue, some airlines have improved their safety briefings by using videos.

Flight emergency water landing, where the flight needs to do an emergency landing on water, rarely happens in Malaysia even though this situation is possible to happen at any time without us expecting it. The survival rate statistics in ditching (a forced or precautionary landing on water) situation is higher (*Commercial-Air-Transport-Issue-2-Amendment-1*, 2019). However, it requires the inevitable condition of a good available spot for ditching.

Sharma [3] state that simulation allows individuals to gain information in a virtual situation that can be connected to real situations, including emergency water landing. Therefore, the use of Virtual Reality (VR), a computer innovation to create a simulated environment, may assist users to immerse and be ready to associate with the 3D world where the exact environmental sounds and spatial qualities are necessary to create an immersive virtual reality experience. Thus, this study aimed to evaluate the usability of a semi-immersive VR simulation for flight emergency water landings, as well as to inform and raise awareness among travellers, especially adult passengers, about how to manage the evacuation procedure in the event of an emergency water landing. In this study, users were trained on the evacuation steps during a flight emergency water landing through VR so that they would be aware if an emergency water landing happens in real life. In accomplishing this, the project's 3D modelling of the flight environment was developed to provide users with a similar experience during flight emergencies. The issue that has to be addressed in this study is the lack of emergency visualisation, particularly when passengers are being forced to land on water on a flight.

2. Literature Review

2.1 Virtual Reality

The human's ability to grasp information is greatly aided by visualisation by providing them with a real situation. In relation to that, VR is a setting with a three-dimensional vision that can replicate the real world for the user. The advantages of adopting VR in daily life include its ability to mimic difficult-to-simulate events like flight simulation, volcanic eruptions, medical procedures, and others [4]. According to Buttussi and Chittaro [5] in terms of information acquisition, retention, and participant confidence, VR is found to be more beneficial compared to other approaches. Besides, VR has also been implemented in wide area of flight learning and gives better learning advantages than traditional simulations [6]. In addition, VR could be more prevalent than smartphones. According to previous research, certain applications have been created to raise awareness of airline safety, such as:

i. optimARes application (*OptimARes: Augmented Reality Seat Viewer for IPad2*, 2011)
ii. Air Safety World (Buttussi & Chittaro)
iii. the Malaysia Airlines Safety Briefing Video (*https://i.ytimg.com)*

But not all these applications concentrate specifically on the water landing process. According to research by Nilsson [7] although there are improvements to be made, the employment of VR for cargo delivery missions in support of future lunar land operations has had a favourable impact. Meanwhile, the use of virtual reality may decrease training costs instead of using an actual environment for doing drilling sessions [8].

2.2 Emergency Simulation

Although real-world scenarios can be used to teach emergency procedures, the pandemic era where social distance, financial constraints, and time constraints are seen to be the concerns that hinder any forms of physical meetings and gatherings. Therefore, as preparing individuals for upcoming catastrophic natural catastrophes through simulation exercises is a crucial problem [9] technologies such as simulation exercises built on visualisation technology may appear to be a more convenient, appealing, and safer alternative during the pandemic in order to expose individuals with emergency procedures. Additionally, a study by Shigunov and Söding [10] found that simulation can be used to count the time for the landing process in an emergency, including time for sinking and flooding. However, their study did not cover the simulation on passenger safety as the finest simulation for an unforeseen circumstance can be created using VR which can replicate both dangerous and safe environments. Azlan [11] in his research states there are lots of technologies used for spreading awareness, enhancing the learning experience, and fostering user engagement about the disaster, including mobile applications, web-based and gamification [12].

Additionally, VR simulations may play a crucial role in the current educational system [13]. According to [14] even though VR simulations might not be as effective as the conventional techniques, it can somehow effectively increase societal emergency preparedness and be employed as one of the strategies for effectively imparting knowledge. Meanwhile, a study by Deng [15] found that simulation of flight evacuation is effective in preparing passengers for an emergency; however, it only focuses on the evacuation process, excluding water landing. There are several types of emergency landings including forced landing which is related to immediate landing caused by engine failure. Another type of landing is precautionary landing, which is determined by a deliberate landing caused by weather, loss, fuel shortage, or gradually engine trouble. Meanwhile, ditching landing is a forced or an emergency landing causes precautionary landing on water, and belly landing with the gear in the “up” position. According to Aviation Services, this is usually caused by equipment malfunction (the gear cannot be extended or cannot reach the locked position) and finally crash landing where the aircraft receives significant structural damage. This present study was carried out to evaluate the usability of learning through virtual simulation for flight emergency water landing. Figure 1 shows the ditching landing made by US Airways flight 1549 after an emergency landing on the Hudson River [16].

Fig. 1. Ditching landing by US Airways Flight

2.3 Usability

Usability is the degree to which committed users can use a product to achieve certain goals effectively, efficiently, and satisfactorily in a predetermined usage context [17]. Inherently, VR applications require human-computer interaction, which requires system and usability evaluation [18].

In the present study, after the project development was completed, the evaluation of the product was carried out via usability testing using the System Usability Scale (SUS). The statements in the SUS questionnaire are commonly matched to the previously mentioned perceptual and ergonomic issues [19]. It is designed to assess websites, mobile devices, and hardware. According to [20] the usability is categorized into seven categories using an adjective rating scale

i. worst imaginable: SUS-score 0 – 12.5
ii. awful: SUS-score 12.6 – 20.3
iii. poor: SUS-score 20.4 – 35.7
iv. ok: SUS-score 35.8 – 50.9
v. good: SUS-score 51.0 – 71.4
vi. excellent: SUS-score 71.5 – 85.5
vii. best imaginable: SUS-score 85.6 – 100.

SUS must be used to measure the usability of the application. Additionally, a minimum of 20 people must participate in the test to produce a better result [21]. According to Kamal Othman [22] SUS is a brief questionnaire of 10 items with a five-point Likert scale, spanning from strongly disagree to strongly agree, containing alternately positive and negative words to prevent answer biases. Besides, SUS has its formula to be used to calculate all the answers by the tester. In doing so, several steps need to be followed to get the most accurate result. Firstly, all the answers need to be converted into numbers. The standard version of SUS has 10 items, each with five steps anchored with "Strongly Disagree" and "Strongly Agree." Besides, it is a mixed-tone questionnaire in which the odd-numbered items have a positive tone, and the even-numbered items have a negative tone [21]. For example, the strongly agree will be converted into 5, agree to 4, moderate will be converted into 3, disagree will be converted to 2 and strongly disagree will be converted into 1. Table 1 shows the grading scale for the SUS results.

Table 1
Curved Grading Scale for the SUS Results [21]

Grade	SUS	Percentile Range
A+	84.1 – 100	96 – 100
A	80.8 – 84.0	90 – 95
A-	78.9 – 80.7	85 – 89
B+	77.2 – 78.8	80 – 84
B	74.1 – 77.1	70 – 79
B-	72.6 – 74.0	65 – 69
C+	71.1 – 72.5	60 – 64
C	65.0 – 71.0	41 – 59
C-	62.7 – 64.9	35 – 40
D	51.7 – 62.6	15 – 34
F	0 – 51.6	0 – 14

3. Material and Methods
3.1 Participants

A total of 30 respondents voluntarily participated in this study where there were 11 male respondents and 19 female respondents. No monetary compensation or incentive was given to drive participation.

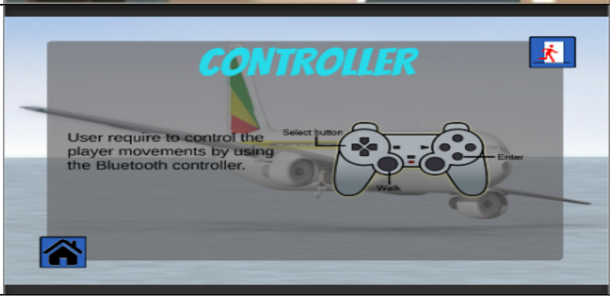
3.2 Procedures

The respondents were briefed on the assessment procedures, and a demo was conducted beforehand to avoid misunderstanding and confusion since more than half of the respondents had no experience in using any VR technology. A laptop and a VR headset were provided for the simulation purpose. There is no time limit for each player to finish the simulation. The SUS questionnaire on Google Form was answered by the respondents immediately after the testing session. The questions were presented in English. Figure 2 shows the testing of the application by a user while Table 2 shows relevant screenshots taken from the application.

Fig. 2. Application testing

Table 2
Screenshots of the application

Screenshot	Description
	The design of the main menu for this project
	Emergency evacuation part I
	Instruction to the passenger

	Emergency evacuation part II
	Controller used to control the application

3.3 Instruments

The SUS questionnaire consisted of 10 items, in which each item was rated on a five-point Likert scale ranging from strongly disagree to strongly agree.

3.4 Developments

This project used the Unity engine to build a high-quality of 3D mobile application that is suitable and capable to build 3D and 2D *environments*, which is the requirement for this project. The application's functionality was coded in MonoDevelop software, which is a built-in software linked with Unity using C# programming language.

4. Results and Discussions
4.1 Demographic Summary

A total of 30 respondents voluntarily participated in this evaluation; most of them were female (N=19, 63.3%). 15 of the respondents (50.0%) were between 18 - 25 years old while nearly half (N=12, 40.0%) of the respondents had experience in using VR, followed by one-third (N=10, 33.3%) of the respondents claimed they have no knowledge about VR. The respondents' demographics are presented in Table 3.

Table 3
Demographic characteristics of the respondents Frequency (N = 30)

Gender	
Male	11 (36.7%)
Female	19 (63.3%)
Age	
Below 18 years	3 (10.0%)
18-25 years	15 (50.0%)
26-40 years	10 (33.3%)
Above 40 years	2 (6.70%)
Knowledge on VR	
Yes	12 (40.0%)
No	10 (33.3%)
Maybe	8 (26.7%)
Experience using VR	
Yes	12 (40.0%)
No	18 (60.0%)

4.2 System Usability Scale

The SUS evaluation tested whether the application meets user's requirements and satisfaction. Generally, all respondents responded positively regarding the ease of use (see questions 3 and 7). The respondents claimed that they had confidence in using the application. These results concluded that the VR technology was acceptable and could be used for simulation purposes. However, there are different opinions from the respondents with regard to the application's complexity. More than one-fifth (N=7, 23.3%) of the respondents found this app to be complex, and 3 of them (10.0%) were unsure. We assumed that some of the respondents were confused when using the system since we used some external devices, and they needed some time to adapt to these devices. This is aligned with [23] who conducted a usability study for emergency simulation training. From their study, they found that some users had problems using the app, cause of the VR headset. In our study, several respondents agreed that there were inconsistencies in this simulation. This was, nevertheless, an expected result since most of the respondents had no experience in using VR.

Additionally, we believe that the VR headsets are the main reason and this is supported by [24] who stated that a Head Mounted Display (HMD) is heavy thus leading to headache and nausea. Additionally, we discovered two key findings in this study:

i. a number of participants (N=13, 43.26%) felt that there is a need for technical support to use this app
ii. one-third of the participants (N=10, 33.3%) felt that there is a need to learn a lot before using this app. These findings are consistent with [25] who stated that first-time users mostly expressed the need for technical support. The results of the SUS evaluation are summarised in Table 4.

Table 4
SUS Score

Survey Items	Frequency (N = 30)				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. I think that I would like to use this system frequently.	0	0	1 (3.33%)	3 (10.0%)	26 (86.6%)
2. I found the system unnecessarily complex	6 (20.0%)	1 (3.33%)	3 (10.0%)	4 (13.3%)	16 (53.3%)
3. I thought the system was easy to use	0	0	0	6 (20.0%)	24 (80.0%)
4. I think that I would need the support of a technical person to be able to use this system	2 (6.66%)	11 (36.6%)	11 (36.6%)	4 (13.3%)	2 (6.66%)
5. I found the various functions in this system were well integrated	0	0	1 (3.33%)	4 (13.3%)	25 (83.3%)
6. I thought there was too much inconsistency in this system	18 (60.0%)	6 (20.0%)	2 (6.66%)	3 (10.0%)	1 (3.33%)
7. I would imagine that most people would learn to use this system very quickly	0	0	0	3 (10.0%)	27 (90.0%)
8. I found the system very cumbersome to use	18 (26.7%)	7 (23.3%)	0	4 (13.3%)	1 (3.33%)
9. I felt very confident using the system	0	0	0	4 (13.3%)	26 (86.7%)
10. I needed to learn a lot of things before I could get going with this system	1 (3.33%)	9 (30.0%)	9 (30.0%)	3 (10.0%)	8 (26.7%)

To measure the usability of the application, there is a need to calculate the SUS score. Firstly, the contributions score from each question was totalled up. For questions 1,3,5,7, and 9, the score contribution is minus 1 while for questions 2,4,6,8, and 10, the score contribution is 5 minus the scale position. Then, to obtain the overall value of SUS, the sum of the scores was multiplied by 2.5.

Table 5
SUS Score

Participant	SUS Score	Participant	SUS Score
P1	87.5	P16	50.0
P2	42.5	P17	80.0
P3	67.5	P18	80.0
P4	77.5	P19	82.5
P5	75.0	P20	77.5
P6	67.5	P21	77.5
P7	90.0	P22	77.5
P8	92.5	P23	75.0
P9	90.0	P24	72.5
P10	95.0	P25	72.5
P11	95.0	P26	75.0
P12	85.0	P27	72.5
P13	82.5	P28	80.0
P14	57.5	P29	82.5
P15	50.0	P30	90.0
		AVERAGE	**76.7**

There was a total of 30 participants (which were labelled as P1, P2, P3, and so forth) in Table 5. The grading of the SUS key is 92 (best), 85 (excellent), 72 (good), 52 (fair), 38 (poor), and 25 (worst).

As the Flight Emergency Water Landing Simulation through VR obtained a score of 76.7, it can be concluded that it is a good application based on the evaluation made by the target audience.

5. Conclusion

In this study, we developed a VR 3D simulation to provide a better view in emergency situations specifically during an emergency water landing, or ditching. A usability evaluation was conducted to ensure this app is usable and meets the user requirements. The overall results showed positive feedback from the respondents with 76.6% of the SUS score. According to the interpretation scheme of Bangor *et al*., and van der Nat *et al*., this value corresponds to a good rating. From this study, we also found that users accepted the VR technology. However, there were some issues highlighted regarding VR usage. First, a VR headset, or HMD, is considered heavy and cumbersome. This factor may lead to a negative user experience in using VR. Even though VR is not a new technology, many people have never tried it. The main reason is the need for an additional external device such as a VR headset. Due to this reason, many people agreed that they needed help and technical support to use the app. While VR technology is exciting, engaging, and has the ability to enhance user experience, future researchers should pay more attention to the technical aspects of VR, especially when an external device is involved. Among the risks of using HMD for a long time are nausea and headache. Furthermore, future researchers should also provide a simple and easy-to-understand user manual to assist users when using VR, considering that most users have not yet experienced or familiarised themselves with VR technology.

Acknowledgement
The researchers would like to express their sincere thanks to UiTM Cawangan Melaka for sponsoring this research under the TEJA Internal Grant numbered GDT2022/1-18. They would also like to express their gratitude and appreciation to all individuals who were directly or indirectly involved in this study.

References
[1] Ruenruoy, Ratchada. "Passengers' perception of the safety demonstration on board an aircraft." PhD diss., Middle Tennessee State University, 2014.

[2] Tehrani, Morteza, and Brett RC Molesworth. "Pre-flight safety briefings, mood and information retention." *Applied ergonomics* 51 (2015): 377-382. https://doi.org/10.1016/j.apergo.2015.06.015

[3] Sharma, Neha, Vibhor Jain, and Anju Mishra. "An analysis of convolutional neural networks for image classification." *Procedia computer science* 132 (2018): 377-384. https://doi.org/10.1016/j.procs.2018.05.198

[4] Piccione, Joseph, James Collett, and Alexander De Foe. "Virtual skills training: the role of presence and agency." *Heliyon* 5, no. 11 (2019). https://doi.org/10.1016/j.heliyon.2019.e02583

[5] Buttussi, Fabio, and Luca Chittaro. "A comparison of procedural safety training in three conditions: virtual reality headset, smartphone, and printed materials." *IEEE Transactions on Learning Technologies* 14, no. 1 (2020): 1-15. https://doi.org/10.1109/TLT.2020.3033766

[6] Pennington, Elizabeth, Riley Hafer, Erin Nistler, Todd Seech, and Chad Tossell. "Integration of advanced technology in initial flight training." In *2019 Systems and Information Engineering Design Symposium (SIEDS)*, pp. 1-5. IEEE, 2019. https://doi.org/10.1109/SIEDS.2019.8735628

[7] Nilsson, Tommy, Flavie Rometsch, Leonie Becker, Florian Dufresne, Paul Demedeiros, Enrico Guerra, Andrea Emanuele Maria Casini, Anna Vock, Florian Gaeremynck, and Aidan Cowley. "Using Virtual Reality to Shape Humanity's Return to the Moon: Key Takeaways from a Design Study." In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, pp. 1-16. 2023. https://doi.org/10.1145/3544548.3580718

[8] Soenarto, Sunaryo, Moh Khairudin, Adhy Kurnia Triatmaja, and Mohamed Nor Azhari Azman. "Improving Competence Trough Virtual Digital Engineering Laboratories with Mobile Virtual Reality." *Journal of Advanced Research in Applied Sciences and Engineering Technology* 31, no. 2 (2023): 157-172. https://doi.org/10.37934/araset.31.2.157172

[9] Li, Ning, Na Sun, Chunxia Cao, Shike Hou, and Yanhua Gong. "Review on visualization technology in simulation training system for major natural disasters." *Natural hazards* 112, no. 3 (2022): 1851-1882. https://doi.org/10.1007/s11069-022-05277-z

[10] V. Shigunov, H. Söding, and Y. Zhou, "Numerical Simulation of Emergency Landing of Aircraft on a Plane Water Surface," (2001).

[11] Azlan, Zulfadli Hazim Zul, and Syahrul Nizam Junaini. "Erudite Survivor: Usability Testing of a Gamification-based Mobile App for Disaster Awareness Among Children." *Journal of Advanced Research in Applied Sciences and Engineering Technology* 31, no. 3 (2023): 290-298. https://doi.org/10.37934/araset.31.3.290298

[12] Azlan, Zulfadli Hazim Zul, and Syahrul Nizam Junaini. "Erudite Survivor: Usability Testing of a Gamification-based Mobile App for Disaster Awareness Among Children."

[13] Dong, Sihui, Fei Yu, and Kang Wang. "A virtual simulation experiment platform of subway emergency ventilation system and study on its teaching effect." *Scientific reports* 12, no. 1 (2022): 10787. https://doi.org/10.1038/s41598-022-14968-3

[14] Behmadi, Saman, Fariba Asadi, Maryam Okhovati, and Roghaye Ershad Sarabi. "Virtual reality-based medical education versus lecture-based method in teaching start triage lessons in emergency medical students: Virtual reality in medical education." *Journal of Advances in Medical Education & Professionalism* 10, no. 1 (2022): 48.

[15] Deng, Xiaoqing. "An Aircraft Evacuation Simulation Baseline Using DES for Passenger Path Planning." (2016).

[16] Sláma, Jakub. "Emergency Landing Guidance for an Aerial Vehicle with a Motor Malfunction." *Bachelor's Thesis, Czech Technical University in Prague, Czech Republic* (2018).

[17] Rauf, Abdul, Shafiq Ur Rehman, Sadia Batool, and Shahid Arshad Ali. "Survey based usability evaluation of MS Word." In *2010 International Conference on User Science and Engineering (i-USEr)*, pp. 193-198. IEEE, 2010. https://doi.org/10.1109/IUSER.2010.5716750

[18] Livatino, Salvatore, and Christina Koffel. "Handbook for evaluation studies in virtual reality." In *2007 IEEE symposium on virtual environments, human-computer interfaces and measurement systems*, pp. 1-6. IEEE, 2007. https://doi.org/10.1109/VECIMS.2007.4373918

[19] Santos, Marc Ericson C., Jarkko Polvi, Takafumi Taketomi, Goshiro Yamamoto, Christian Sandor, and Hirokazu Kato. "Toward standard usability questionnaires for handheld augmented reality." *IEEE computer graphics and applications* 35, no. 5 (2015): 66-75. https://doi.org/10.1109/MCG.2015.94

[20] van der Nat, Denise J., Victor JB Huiskes, Margot Taks, Bart PH Pouls, Bart JF van den Bemt, and Hein AW van Onzenoort. "Usability and perceived usefulness of patient-centered medication reconciliation using a personalized health record: a multicenter cross-sectional study." *BMC Health Services Research* 22, no. 1 (2022): 1-17. https://doi.org/10.1186/s12913-022-07967-7

[21] Lewis, James R., and Jeff Sauro. "Item benchmarks for the system usability scale." *Journal of Usability Studies* 13, no. 3 (2018).

[22] Othman, Mohd Kamal, Altynai Nogoibaeva, Lai San Leong, and Mohamad Hardyman Barawi. "Usability evaluation of a virtual reality smartphone app for a living museum." *Universal Access in the Information Society* 21, no. 4 (2022): 995-1012. https://doi.org/10.1007/s10209-021-00820-4

[23] Lerner, Dieter, Stefan Mohr, Jonas Schild, Martin Göring, and Thomas Luiz. "An immersive multi-user virtual reality for emergency simulation training: usability study." *JMIR serious games* 8, no. 3 (2020): e18822. https://doi.org/10.2196/18822

[24] Alapakkam Govindarajan, Mrityunjaya A., Philippe S. Archambault, and Youri Laplante-El Haili. "Comparing the usability of a virtual reality manual wheelchair simulator in two display conditions." *Journal of Rehabilitation and Assistive Technologies Engineering* 9 (2022): 20556683211067174. https://doi.org/10.1177/20556683211067174

[25] Breitkreuz, Karen R., Suzan Kardong-Edgren, Gregory E. Gilbert, Connie DeBlieck, Mariam Maske, Christy Hallock, Susan Lanzara *et al.,* "A multi-site study examining the usability of a virtual reality game designed to improve retention of sterile catheterization skills in nursing students." *Simulation & Gaming* 52, no. 2 (2021): 169-184. https://doi.org/10.1177/1046878120954891