Spring 2024

Chapter 10: Increasing Accessibility in Educational Simulations

Meaghan McLeod
Old Dominion University

Instructional Message Design:
Theory, Research, and Practice
(Volume 3)

Chapter 10: Increasing Accessibility in Educational Simulations

Meaghan McLeod
Old Dominion University

Citation:

McLeod, M. (2024). Increasing Accessibility in Educational Simulations. In M. Ramlatchan (Ed.), *Instructional Message Design: Theory, Research, and Practice* (Vol. 3). Kindle Direct Publishing.

10. Increasing Accessibility in Educational Simulations

Meaghan McLeod

Key Points:

- A key educational benefit of instructional simulations is repetition and feedback.
- Often accommodations and accessibility features are overlooked and not included in the final design.
- Beyond closed caption and transcripts, designers can also include speech to text options, sonification, different input and control peripherals, and multimedia to enhance message design for learners.

Abstract

Simulations are an important aspect of education and training. They provide the learner with situations that mirror real life situations or provide access to unobservable phenomena. The simulations provide the learner with a unique opportunity to master skills through the use of and practice in a safe environment. However, many simulations are not designed with accessibility and accommodations in mind. This chapter provides a general overview of simulations and provides suggestions on how to increase accessibility and enhance the learning experience for all learners.

Keywords: Educational Simulations, Accessibility, Instructional Message Design, Accommodations

Introduction

Education simulations provide an opportunity for learners to practice real-life situations without physically being present (Chernikova et al., 2020). Learners can experience situations and troubleshoot problems without the risk of damaging equipment and hurting themselves or others. The learner also develops confidence and proficiency when using simulations (Hannel & Cuevas, 2018). The simulation's active hands-on approach and participation components spark interest and motivation as it provides an experience that mimics the real world (Lunce, 2006). Educational simulations allow learners to experience a variety of rare situations often not found in an in-classroom educational setting and can be more effective at improving learner performance over traditional classroom strategies (Satre, 2022). An educational benefit of simulations is repetition and time. The learners gain practice and mastery of skills as they repeat learning scenarios. They also can take extra time in scenarios if needed (Kaufman & Ireland, 2016).

Traditional learning materials, including simulations, are often designed for a generalized learner. Someone who can see, hear, and physically and mentally interact with the material as it is. Nevertheless, does that learner exist? Often accommodations and accessibility features are overlooked and not included in the final design. Time, knowledge, and resources impact the amount of accessibility designed into the simulations and learning materials. If the goal of the simulation is to have the learner practice and master the skills needed to perform the task in the real world, or to experience unobservable phenomena, then all actions should be taken so that the learner can be successful – including implementing accommodations and accessibility.

This chapter explores the different types of simulations. Then describes a general overview of the framework associated with simulations. Next, this chapter discusses the current accommodations that are being used in simulations. Finally, strategies on how to implement accommodations to improve the overall quality of learning simulations for all learners are presented.

Simulation Modalities

Simulations are often used to increase diagnostic, motor, and technical skills for healthcare professionals, teachers, management (Chernikova et al., 2020), military personnel, and educational settings. The following is a list of different types of simulations.

Simulated clinical immersion (SCI) is a simulation where students interact with mannequins (Satre, 2022). Mannequins are primarily used in medical training and range in sophistication and size. Some are region-specific (head and neck), while others are full-body. The mannequin simulators can be used for diagnostic and treatment training. Some of the higher-fidelity mannequins exhibit breathing, heartbeat, pulse, and bleeding (Kunkler, 2006).

Role play and the standardized patient is a simulation where the learner interacts with a human acting as a patient (Satre, 2022). This simulation represents a patient problem in a realistic clinical setting (Oh et at., 2015). The patient is coached and trained on how to react to the learner's intervention strategies.

Situational simulations mimic human behavior and place learners in specific roles. (Lunce, 2006). The goal of the situational simulation is to have the learner experience a real-world situation, whether it be managerial, technical, or other external events. The learner is tasked with specific responsibilities based on their role and is expected to uphold professionalism. Therefore, the simulations should provide accurate information regarding the real-life situation (Rojas & Mukherjee, 2005).

During procedural simulations, the learners master skills by manipulating simulated objects (Lunce, 2006). Procedural simulations play a critical role in healthcare training (Kneebone, 2005) and bridge the gap between skill development outside the operating room and performance inside the operating room (Våpenstad & Buzink, 2012).

Computer-based simulations provide an online platform where large numbers of learners from various geographic locations are able to participate. The platform allows learners to observe, manipulate, practice, and interact with unobservable phenomena. Computer-based simulations usually include interactive videos, multimedia, and verbal material and can include authentic narratives and realistic situations (Dubovi, 2018; 2019). Computer-based simulations can be based on realistic situations and involve conceptual experiments. This is where the learner uses critical thinking skills and deepens understanding as they manipulate variables, collect data, and draw conclusions (Hannel & Cuevas, 2018). Effectively computer-based simulations, both realistic and conceptual, demonstrate what learners may encounter in real-world scenarios and their future careers (Dubovi, 2018; Hannel & Cuevas, 2018).

Virtual reality (VR) simulations allow the learner to be immersed in a situation. To enter the VR environment, the learner usually wears a VR headset and uses handheld controllers or haptic gloves. Learners experience multiple senses like visual, haptic, and, less often, olfactory. VR simulations demand elaborate graphics and realistic interfaces (Våpenstad & Buzink, 2012). Although VR-simulations are computer-based, the difference is the immersive aspect. The learner perceives they are physically present in a non-physical environment and may feel temporarily disconnected from time and the real world (Radianti et al., 2020).

Common Simulation Framework

Each simulation contains one or more scenarios. The scenario happens during the simulation and involves characters and objects. The scenario determines the role of the learner, interactive prompts, and how the simulation will respond (Reigeluth, Schwartz, 1989). Branching is a series of decisions and actionable steps embedded in the learner's scenario. One benefit of branching is that learners receive immediate feedback based on the decisions made (Rababa et al., 2022). Feedback provides the learner with confirmation of correct actions and responses. Natural feedback mirrors real-life consequences. For example, during a flight simulation, the learner may view a shift in altitude and fuel dials based on their decisions (Reigeluth & Schwartz, 1989).

Many simulations contain a pre-brief and a debrief. The pre-brief acts as an orientation session where information is given to the learner before the simulation starts. The information provided usually includes instructions on how to go through the simulation, objectives of the simulated scenario, safety concerns, and learner expectations. The debrief provides an opportunity for reflection and feedback on the learner's decisions and actions (Verkuyl et al., 2022). The debrief summarizes and reinforces key takeaways to emphasize what the learners have learned and experienced.

Current Accommodations

Since simulations provide educational and workforce training, it is important to discuss accommodations, accessibility, and inclusion. According to the U.S. Department of Labor, accommodations are modifications to the job or the work environment. These modifications provide an equal opportunity for individuals with disabilities to get jobs and perform their tasks to the same extent as employees without disabilities (U.S. Department of Labor, nd.). According to digital.gov, an official website of the U.S. government, "Under Section 508 of the Rehabilitation Act of 1973, agencies must give disabled employees and members of the public access to information comparable to the access available to others" (Digital.gov, nd.). *Accessibility* is defined as eliminating unnecessary barriers preventing someone from engaging in everyday activities (JISC, nd.). *Inclusion* is defined as a fundamental right for individuals to fully participate and contribute in all areas of life without restrictive barriers and marginalization (Braunsteiner & Mariano-Lapidus, 2014). I define *inclusion* in education as the opportunity and acceptance of all students to participate and contribute to quality educational materials and tools.

The ultimate goal is to create products and services, in this case, simulations, that do not need accommodations as they are already implemented into the design, and all learners can access them. PhET (Physics Education Technology, https://phet.colorado.edu/) interactive simulations seem to be leading in this area. PhET provides free computer-based physics, biology, chemistry, math, and earth science simulations. Their simulations stand out as being accessible. Design experts were brought in early during the design process to include accommodations (Winters et al., 2020). Due to limited accessible resources, students with disabilities too often miss out on authentic STEM (science, technology, engineering, and mathematics) experiences (PhET, 2023) . Using inclusive design approaches, PhET designers are tackling software, assistive devices, and STEM education to provide research-based accessible simulations for all learners. The simulations created by PhET include the following accessible features: alternative input, interactive description, sound and sonification, voicing, panning features, and zooming options (PhET, 2023).

People with disabilities are often excluded from the conversations surrounding and implementing accommodations, creating a design mismatch (Holmes, 2018). "Product Inclusion is the practice of applying an inclusive lens throughout the entire product design and development process to create better products." (Jean-Baptiste, 2020, p. 20). PhET seems to be on board with this philosophy along with Winters, Harden, and Moore, who developed a research study based on a design thinking process with visually impaired teens. The goal was to have the participants, visually impaired teens, design and test sonification (or the use of auditory cues) within a simulation. The nonspeech audio, sonification, was a successful motivator. The entire design process promoted empowerment among the participants (Winters et al., 2020).

Carroll, Eaton, & Lusk provided a case study on a deaf nursing student Anna. Anna could lip read and wore a hearing aid which enabled her to hear some sounds. Carroll and Eaton mapped out ways to accommodate Anna during the training simulations. For example, one of the training simulations included a high-fidelity mannequin with audio. The barrier is the delivery of information - audio. The authors suggested the following accommodations: Anna can read from a script, use an automated captioning app, provide a staff member to repeat the audio from the mannequin, or hire a standardized patient (so that Anna could lip read) (Carroll et al., 2021). Without the accommodations, Anna could not access the information and, therefore, could not respond to the simulation. However, by implementing an alternate delivery of information, Anna could understand the prompts and test her skills during the simulated scenario. Carroll, Eaton, and Lusk bring up a critical point regarding Anna's situation. "The academic program should not assess or measure student competencies based on the essential functions of a nursing job. Rather, they should use ADA-compliant technical standards that pertain only to academic success." (Carroll et al., 2021 p.100). The Americans with Disabilities Act (ADA) prohibits discrimination against people with disabilities and guarantees that they have equal employment and government services, including public education opportunities (ADA, n.d.). According to the Department of Education, section 504 of the Rehabilitation Act requires that students with disabilities receive services to meet their individual needs to the same extent as students without disabilities (U.S. Department of Education, 2023), which means that services are allowed to provide an equal opportunity to learn.

In Anna's case with the high fidelity mannequin, by adding a script or a staff member to speak, Anna is still receiving the same information as the other students, just in a delivery method that meets her needs. Since Anna is in a training program, the goal is academic success. Unfortunately, ADA standards tend to fall through the cracks and are not always a priority when designing simulations. Therefore, simulation designers should be familiar with ADA laws and various accommodations. Training simulations bridge applied academic knowledge to real-life situations. However, simulations could be a valuable tool to provide an opportunity to test the best way to incorporate accommodations in work situations. An example would be a simulation where an employer and employee can sample various accommodations within a work environment.

Strategies to Include Accommodations

Designers typically design for non-disabled users and do not consider the needs of users with different capabilities or do not understand how to include accommodations in the product (Keates et al., 2000). Many websites provide valuable information and resources regarding accommodations.

- Information Management System Global Learning Consortium (IMS GLC) provide guidelines for accessible learning applications (1EDTECH, nd.).

- World Wide Web Consortium WCAG, provides tools to improve web accessibility (W3C, 2023).

- Digital.gov provides information about accessibility, types of disability, and provides posters of design do's and don'ts for invisible disabilities like anxiety and dyslexia (Digital.gov, nd.).

- Web Aim is a contrast checker website that allows the user to input both foreground and background colors to ensure they meet AA and AAA web accessibility standards (Webaim, 2023).

- CAST is a nonprofit that created the Universal Design for Learning (UDL) which is a framework designed to optimize both teaching and learning (CAST, 2023).

It is hard as a designer to understand the specifics of the learners using your simulations and what kind of learning needs they require. However, learners who do not have specific learning needs may also benefit from the added accommodations.

The simulations that require human-to-human or mannequin collaborations can include scripts of the interactions and branching. The added text can help those who experience hearing, audio processing, and anxiety. Include text and visuals in the pre-brief and debrief. The combination of graphics and words trigger mental receptors and provides the organizational structure for the content (Martin & Betrus, 2019). Using standardized patients instead of mannequins is an acceptable alternative in a clinical scenario (Carroll & Eaton, 2019).

Computer-based simulations, including VR, can incorporate the following in the design to enhance the learning experience for the learners. Beyond closed captions and transcripts, designers can also include an option for combining audio and text, especially for directions and branching options. Text-to-speech features can increase the ease of read-aloud (Scalise et al., 2018). Applying audio can assist learners with visual impairments along with cognitive issues. Combining text (written or audio) with graphics creates a more profound learning experience (Martin & Betrus, 2019). The designers can include alternative inputs like keystrokes, joysticks, touch screens, or eye tracking.

Extraneous designs can distract and confuse the learner and cause them to experience cognitive overload (Ramlatchan, 2022). Cognitive load is the amount of new information being processed into a learner’s long-term memory. Knowledge development would be significantly impacted if the information was increased beyond the learner's limits (Shaffer, 2022). Therefore, offering accessible options to be turned off and on by the learners would ease cognitive overload and empower them to choose the features that suit their learning needs. Providing short breaks during the simulations can allow the learner to rest their eyes if on a screen too long, and can act as a mental break.

Message design is used to facilitate an appealing design optimal for learning. Message design combines images, text, and video to communicate a message, address a need, and direct learners' attention (Ramlatchan, 2022). Message design can be strategically used to provide accessibility features like contrast, alt text which describes images, limit the amount of text on the screen at one time, and use multimedia instead of a single format.

Audio descriptions of the scenario and environment can be included for learners with visual impairments. An instructor can provide the audio description, a Word or PDF document that is text-to-speech compatible can be another alternative, or an audio description can be embedded into a computer-based simulation.

Accommodations should be seen as a means to optimize learning and give learners the resources they need to be successful. "The process of how someone achieves a skill is less important than the successful outcome of the skill achievement" (Carroll & Eaton, 2019, p. 620). There is no such thing as a standardized learner. Each learner has their own learning style, whether it be visual, auditory, or kinesthetic (Willingham et al., 2014). To expand, each learner has specific needs and optimal learning environments. As a designer, it is hard to anticipate specific needs. Therefore, familiarizing themselves with various accommodations and means of presenting information would greatly benefit the learner. Simulations should be designed so all learners can have an equal opportunity to master the skills.

Conclusion

Research strongly suggests learners assimilate information more effectively when actively involved and engaged in learning experiences. Simulations provide an active approach to learning and allow learners to put their current knowledge into practice (Hannel & Cuevas, 2018). Furthermore, simulations play an essential role in job training and education; therefore, all learners should have the opportunity to equally participate in simulations. This chapter provided a few examples of increasing accessibility and learning within simulations. Further research and testing needs to be done regarding the implementation and assistive devices that can be used. A standard guide should be created to assist learning simulation designers on how to optimize learning for all learner types.

References

ADA.gov. (n.d.). Introductions to the Americans with Disability Act. Introduction to the Americans with Disabilities Act | ADA.gov

1EdTech. (nd.). 1EdTech guidelines for developing accessible learning applications. 1EdTech Guidelines for Developing Accessible Learning Applications | IMS Global Learning Consortium

Braunsteiner, Maria-Luise & Mariano-Lapidus, Susan (2014). A perspective on inclusion: Challenges for the future. *Global Education Review, 1*(1). 32-43.

Carroll, S.M., & Eaton, C. (2019). Accessible simulation: a necessity in nursing education. *Journal of Nursing Education,* 58(11), 619-621. https:// doi:10.3928/01484834-20191021-01

Carroll, S.M., Eaton, C.M., Lusk, M. (2021). The student with a sensory disability: Anna Howard, a deaf nursing student. In: Neal-Boylan, L., Meeks, L.M. (eds) *Disability as Diversity.* Springer, Cham. https://doi.org/10.1007/978-3-030-55886-4_10

CAST. (2023). About CAST. CAST: About CAST

Chernikova, O., Heitzmann, N., Stadler, M., Holzberger, D., Seidel, T., Fischer, F. (2020). Simulation-Based learning in higher education: a meta-analysis. *Review of Educational Research,* 90(4), 499–541 https://doi.org/10.3102/0034654320933544

Digital.gov. (nd.). An introduction to accessibility. An Introduction to Accessibility – Digital.gov

Dubovi, I. (2018). Designing for online computer-based clinical simulations: evaluation of instructional approaches. *Nurse Education Today,* 69, 67-73 https://doi.org/10.1016/j.nedt.2018.07.001.

Dubovi, I. (2019). Online computer-based clinical simulations: The role of visualizations. *Clinical Simulation in Nursing,* 33, 35-41. https://doi.org/10.1016/j.ecns.2019.04.009.

Hannel, S. L., & Cuevas, J. (2018). A Study on science achievement and motivation using computer-based simulations compared to traditional hands-on manipulation. *Georgia Educational Researcher,* 15(1), 41-55. https://digitalcommons.georgiasouthern.edu/gerjournal/vol15/iss1/3

Holmes, K. (2018). *Mismatch How Inclusion Shapes Design*. Massachusetts and London: The MIT Press

Jean-Baptiste. (2020). *Building for Everyone*. Hoboken, New Jersey: John Wiley & Sons.

JISC. (nd.). Getting started with accessibility and inclusion. [Getting started with accessibility and inclusion | Jisc]

Kaufman, D., & Ireland, A. (2016). Enhancing Teacher Education with Simulations. *TechTrends,* 60,260–267. DOI 10.1007/s11528-016-0049-0

Keates, S., Clarkson, P.J., Harrison, L.A. Robinson, P. (2000). Towards a practical inclusive design approach. [Conference Session] Universal Usability (CUU '00). Association for Computing Machinery, New York, NY, USA, 45–52. https://doi.org/10.1145/355460.355471

Kunkler, K. (2006). The role of medical simulation: an overview. *The international Journal of Medical robotics and computer assisted Surgery*, 2, 203–210.

Lunce, L.M. (2006). Simulations: bringing the benefits of situated learning to the traditional classroom. *Journal of Applied Educational Technology*, 3(1). 37-45.

Martin, F. & Betrus, A. (2019). *Digital Media Design Theories and Principles.* Springer Nature Switzerland AG.

Oh, P.J., Jeon, K. D., & Koh, M.S. (2015). The effects of simulation-based learning using standardized patients in nursing students: a meta-analysis. Nurse Education Today, 35(5) 6-15. https://doi.org/10.1016/j.nedt.2015.01.019.

PhET Interactive Simulations. (2023). Accessibility. Accessibility (colorado.edu)

Rababa, M., Bani-Hamad, D., & Hayajneh, A.A. (2022). The effectiveness of branching simulations in improving nurses' knowledge, attitudes, practice, and decision-making related to sepsis assessment and management. *Nurse Education Today,* 110, 1-7. https://doi.org/10.1016/j.nedt.2022.105270.

Radianti, J., Majchrzak, T.A., Jennifer Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education: design elements, lessons learned, and research agenda. *Computers & Education,* 147, 1-29. https://doi.org/10.1016/j.compedu.2019.103778

Reigeluth, C. M., & Schwartz, E. (1989). An instructional theory for the design of computer-based simulations. *Journal of Computer-Based Instruction,* 16(1), 1-10.

Rojas, E. M., & Mukherjee, A. (2005). General-purpose situational simulation environment for construction education. *Journal of Construction Engineering and Management,* 131(3), 319-329. https://doi.org/10.1061/~ASCE!0733-9364~2005!131:3~319!

Ramlatchan, M. (2022). Message design for instructional designers – An introduction. In M. Ramlatchan (Ed.), *Instructional Message Design: Theory, Research, and Practice* (Vol. 2). Kindle Direct Publishing.

Satre, M. (2022). Message Design for Healthcare Simulation. In M. Ramlatchan (Ed.), *Instructional Message Design: Theory, Research, and Practice* (Vol. 2). Kindle Direct Publishing.

Scalise, K., Irvin, P. S., Alresheed, F., Zvoch, K., Yim-Dockery, H., Park, S., Landis, B., Meng, P., Kleinfelder, B., Halladay, L., & Partsafas, A. (2018). Accommodations in digital interactive STEM assessment tasks: current accommodations and promising practices for enhancing accessibility for students with disabilities. *Journal of Special Education Technology,* 33(4), 219–236. https://doi.org/10.1177/0162643418759340

Shaffer, E. L. (2022). Cognitive Load Theory and Instructional Message Design. In M. Ramlatchan & C. Kohler (Eds.), *Instructional Message Design: Theory, Research, and Practice* (Vol. 2). Kindle Direct Publishing.

U.S. Department of Education. (2023). *Protecting Students with Disabilities.* Protecting Students With Disabilities (ed.gov)

U.S. department of labor. (nd.). Accommodations. Accommodations | U.S. Department of Labor (dol.gov)

Verkuyl, M., Taplay, K., Atack, L., Boulet, M., Dubois, N., Goldsworthy, S., Merwin, T., Willett, T., & Job, T. (2022). *Virtual simulation: an educator's toolkit.* Centennial College.

Våpenstad, C., Buzink, S.N. (2013). Procedural virtual reality simulation in minimally invasive surgery. *Surgery Endoscopy,* 27, 364–377. https://doi.org/10.1007/s00464-012-2503-1

W3C. (2023). Accessibility Fundamentals Overview. Accessibility Fundamentals Overview | Web Accessibility Initiative (WAI) | W3C

WebAIM (2023). Contrast checker. WebAIM: Contrast Checker

Willingham, D.T., Elizabeth M. Hughes, E. M., and David G. Dobolyi, D.G. (2015). The scientific status of learning styles theories. *Teaching Psychology,* 42(3), 266-271. DOI: 10.1177/0098628315589505

Winters, R. M. E., Harden, L., & Moore. E.B. (2020). *Co-designing* *accessible science education simulations with blind and visually impaired teens.* [Conference session] 22nd International ACM SIGACCESS Conference on Computers and Accessibility (ASSETS '20), Greece. ACM, New York, NY, United States. https://doi.org/10.1145/3373625. 3418025