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Approaches to Implementing Virtual Reality for All

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Introduction

The potential of using virtual reality (VR) in education has been discussed for many years, but there are still several barriers that prevent educators in both the K-12 and higher education levels from implementing VR in their courses. Many educators do not have access to high-end VR hardware, software, or a programming team to build custom learning experiences and, as a result, they may not be sure how they can utilize VR. Even with access to high-end VR hardware, there are several accessibility considerations to address when planning the effective implementation of VR activities in a course. Even though accessibility is beginning to come to the forefront in the design of VR, there are still improvements to be made (Mott, et al., 2019). This paper will review some practical approaches and strategies that center around the following three main areas of access: accessibility considerations of using VR, access to available technology (hardware and software), and access to free or low-cost VR experiences.

Levels of VR implementation

With the increase of virtual reality content available via mobile applications and the internet (e.g., 360 images and videos), VR is no longer limited to those with high-end VR hardware and software. Although sophisticated VR hardware and software are ideal for a fully immersive VR experience, low-tech options, such as mobile devices and cardboard headsets, provide a viable entry-point for utilizing virtual reality in the classroom. Due to this increased access to VR content and options for how users engage with this content, it is easier for students to access VR content on their own devices. These factors help reduce the cost and access barriers previously associated with VR, help address the needs of varying learners, and provide options for educators to utilize this technology in face-to-face and online courses.

The wide range of hardware and software options can make it difficult for educators to determine where to start and how to effectively utilize VR with students. When thinking about how VR could be utilized in a course, it is important to start by identifying the resources available and the level to which VR can be implemented. For the purposes of this paper, three levels of VR implementation have been identified: Level 1: VR Lite, Level 2: Immersive VR, and Level 3: Custom+ Immersive VR. Each of the three levels is described in detail below,

starting with a bring-your-own device model ranging to more sophisticated hardware and software. (Refer to Image 1.1 below for more details).

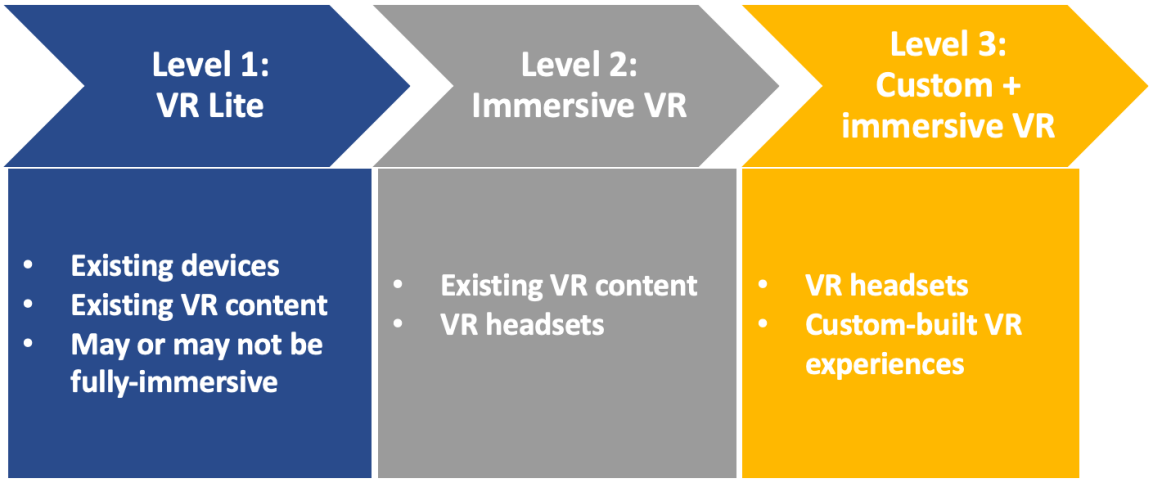

Image 1.1: Levels of VR Implementation

Level 1: VR Lite, involves the use of existing and commonly available hardware (e.g., mobile devices, laptops) and existing VR software (e.g., free or low cost). In this VR lite level, students view VR content using via mobile applications (free or paid) or free, browser-based experiences (e.g., 360 images and videos). This level provides the most flexibility in how the VR content is accessed and viewed since students may use a laptop or mobile device with no additional hardware to view the content, or students may use a mobile device in conjunction with a free or low-cost cardboard headset to make the experience more immersive. While this level is the least immersive of the three levels of implementation, it provides a low cost, flexible approach that supports the needs of varying learners. As a result, VR Lite is a viable option to implement VR in both in-person and distance learning courses. The strategies and resources presented in this paper will focus on implementing this Level 1:VR Lite.

Level 2: Immersive VR, is when existing VR software is utilized with VR headsets of higher quality than cardboard headsets. The higher quality VR headsets come at a greater cost than cardboard headsets but provide students with a more immersive experience and may also involve enhanced audio elements and movement (e.g., hand controls, walking). It is likely that the higher quality VR headset would need to be accessed on campus in a shared physical space and would limit this experience to in-person class interactions. One possible scenario may be to use a combination of Level 1 and 2 if the budget and course modality support this.

Level 3: Custom + Immersive VR, involves the use of high-end VR hardware and access to custom-built VR experiences. Some institutions may have access to a team of programmers and designers who can build unique VR experiences specific to course learning goals. Due to the

cost and resources required for this level of VR implementation, this is the least common scenario for the majority of educators at this point in time.

Accessibility Considerations

As with any technology utilized in courses, regardless of modality, it is helpful to consider varying student needs and accessibility issues prior to the implementation of VR hardware/software to ensure all students can engage with the technology. While specific disabilities (e.g., visual, physical, cognitive) present varying obstacles for students engaging with VR, there are strategies that can be utilized to try to reduce these obstacles. Considering the hardware, software, and accessibility needs from the start when searching for and implementing VR activities will help ensure a successful experience for all.

Even though VR has been around for quite some time, accessibility considerations for individuals with disabilities or even for individuals with something as common as motion sickness have not always been explored for each piece of VR hardware or software. Perhaps due to an increase in accessibility awareness, access to this equipment, and/or a decrease in the cost of software and hardware, or perhaps a combination of these, this is no longer the case. (Zhao, Y. 2019). According to Aguilo, B., et al. (2019), designing accessibility features in the area of VR is still in its infancy and although the research process to improve accessibility is in progress, it is not standard practice across the board.

When planning to implement VR in your course, please consider the following possible limitations that one or more students in your class could be affected by (this is by no means an exhaustive list of limitations):

- Hearing (deaf or hard of hearing)
- Vision issues (low vision/blindness/glasses
- Cognition/Emotional/Learning Disabilities
- Physical limitations

Hearing (deaf or hard of hearing)

At this point in time, it is not likely that captions will be available in free or low-priced VR technology. If VR technology is speech heavy or the audio relays essential information or meaning in the VR product, this may be the time to have an alternate product available for the student's use or perhaps a different product should be used altogether. When reviewing the VR technology (hardware/software) you are considering implementing into the assignment, consider reviewing for the presence of the following items:

- Captions
- Ability to add or use American Sign Language (ASL)
- The types of sounds included in the program:
    - Is there narration that is critical to the meaning of the product?
    - Are there background sounds?
    - Are there sound effects present that add important details to the software?

Blind or Low Vision

Many VR technologies rely on people's vision in order to enjoy, participate, or learn from using VR products (Zhao, 2019). Think about the students in your class and if they have any visual limitations. As with students who may have a hearing limitation, those VR products that require students to rely on visual cues may leave students with visual impairments behind (Zhao, 2019).

In addition, VR use can cause nausea, vomiting, eye strain, and headaches (Velicovic, 2021; Saredakis D, et al, 2020; Caddy, B, 2016). Nausea and/or motion sickness in VR can be caused by VR headsets that have what is called high latency, which means taking a long amount of time for the motion from the technology to be detected or perceived by the brain (Caddy B. 2016). In general, the more expensive the equipment, the less latency, and the less side effects it may cause (Liagkou, et al., 2018). Therefore, if it is unknown whether students are susceptible to VR nausea/motion sickness, have students sitting when using the product, start out slow limiting students' time using the technology, and build up slowly to the amount of time they use can the equipment without side effects.

VR headsets may also be uncomfortable for some students or difficult for other students to wear with glasses depending on the type of headset used. Fortunately, the price for better headsets is starting to decrease. In addition, for those with low vision, VR headsets may enhance the quality of what is seen. To help improve VR for individuals with low vision, Microsoft has created several free to use apps that can significantly improve what students with low vision can see and they can also adjust text to meet their needs! It is open source and free to use (Zhao, 2019). (For more information on these apps go to the SeeingVR website: https://github.com/microsoft/SeeingVRtoolkit/blob/master/LICENSE)

Students who are completely blind may benefit from using haptics (using touch to help determine the size, shape, and movements of objects/scenes in the program) to enjoy or benefit from VR technology (Almedia, 2020). Haptics and VR have successfully been used in nursing training for many years (Butt, 2018). Haptics has also been used in specialized canes to help blind/low vision users maneuver around VR games (Siu, 2020), but very little information can be located that tends to include haptics when using free or low-cost technology.

Cognitive/Emotional/Learning Disabilities

For students who may have cognitive, emotional and/or learning disabilities, VR can often act as a safe space that helps students not only enjoy what they're doing but learn how to handle different experiences in a non-threatening environment (Yahkubova, 2021). In these spaces students can practice social interactions and VR has also been found to help increase student engagement when using this immersive technology. However, when implementing various types of activities, consider possible emotional triggers (something that can elicit an intense emotional reaction) when selecting VR content. Keep activities light and simple.

Physical

VR may require body movements that are difficult for individuals with physical disabilities. Physical disabilities can include a wide range of movement issues including problems with head movements such as side to side movements, difficulty with hand or arm movements, or difficulty or inability to walk (maybe requiring the use of a wheelchair). There are studies currently happening to address many types of physical disabilities and the use of VR (Mott, 2020). It is therefore important that the types of VR used require simple movements. Check with the student or appropriate school personnel (e.g., physical therapists) if you have questions about a student's abilities to participate in a particular use of VR technology or if you are not sure whether a student will be able to access a program using the VR technology that is available, locate similar VR content that is easy to access and available via a web browser.

Strategies to Address Accessibility Issues

As mentioned above, there are a variety of accessibility issues to consider when planning the implementation of VR in your course. It is difficult for educators to address all of these. Below is a list of strategies to apply when planning and testing the implementation of VR to help identify possible accessibility issues and consider accommodations for students who may need them.

- Test the technology yourself. If possible, test accessing the VR content using different devices (e.g., laptop, mobile device, with or without cardboard headset). Note the physical movements, visual or auditory queues you may need to follow when engaging with the VR content.
- If possible, provide options on how students view the VR content rather than requiring the use of a VR headset.
- Be aware of your students' limitations.
- Provide clear directions for students on how to access the VR content and the steps you would like them to take.
- Include safety tips, such as sitting when starting and finding a space with enough room to engage with VR, in the directions for your VR activity.
- Pair students up or consider having students work in groups if in a shared physical space.
- Allow students with low vision to use higher end VR headsets if available, since these may help improve vision.
- Test physical movements that are required when viewing a 360 image:
    - Computer keyboard/mouse
    - Mobile device
    - Hold a VR headset and move your head
- Try using the keyboard arrows to see if they can be used to access a VR product.

Design Considerations

Before focusing on the hardware and software that will be utilized, an important next step is to identify the goals and purpose of the VR experience. According to Jowallah, et al. (2018), "the planning process should begin outside of the technology considerations entirely and

incorporate sound planning and design principles." By first focusing on the learning goals rather than the technology, it will be easier to determine what types of VR experiences will best align with the goals which will also help narrow the scope of your search for VR content. Developing clear learning goals for the VR activities and sharing these goals with students will give students a better understanding of why they are using VR and how the VR activities are connected to the educational goals.

Another important consideration during the design phase is the assignment design. This includes identifying the instructional strategy you would like to utilize (e.g., virtual field trips, scavenger hunts), designing the student experience and determining any desired affective responses (e.g., hearing other perspectives, having an emotional response). Identifying these elements of the assignment will provide helpful guidance as you search for and test VR experiences to make sure they align with the goals of the activity. Other important elements of assignment design include writing directions, reflection questions, or discussion prompts for students to respond to during and/or after the VR experience and determining if students will work individually, with partners, or in groups.

In addition, different course modalities present different challenges when designing VR experiences. For example, when reviewing or implementing VR activities for face-to-face courses, technology may be provided to students to utilize. However, there may be situations where there is not enough technology for all students to participate at once. It may be beneficial for students to pair up when using this technology when there is limited hardware available. Additional benefits of small groups of students engaging in VR experiences together is the opportunity for deeper discussions and allowing students to guide and help each other while using the equipment. Implementing VR activities for fully online courses where students are remote may be possible utilizing a bring-your-own device model; however, this presents challenges since some students may not have access to the required technology.

Hardware Considerations

The modality of the course and the VR software being utilized will help determine the hardware requirements for the VR experience. If students are in the same physical location, a computer lab or shared devices (e.g., mobile device, cardboard headset) may be utilized. Alternatively, a bring-your-own device model could be utilized. If the students are remote, it is important to survey students and ask if they have access to a mobile device and other hardware required for the assignment to identify hardware limitations they may have and how they will interact with the VR content. A few questions for you to answer as you determine the hardware requirements and the level to which you can implement VR in your course are provided below:

Questions to consider when determining hardware requirements:

- Do students have access to a mobile device?
    - If you are asking students to install a VR app on their personal device, do they have the permissions and space to do so?

    - For face-to-face courses: You may consider having a mobile device with the VR app pre-loaded for students to use in class as a back-up for those who cannot install the app.
- If students do not have access to a mobile device or cannot use the mobile device due to accessibility concerns, is the VR experience also accessible via a web browser?
- Will students have access to a VR headset (e.g., cardboard)?
    - If not, how will they view the VR content?
- If audio elements are included in the VR content, do students have access to headphones to make the experience more immersive?
- Do students have access to a safe space to interact with VR content?
    - If movement is involved, is the space large enough?
    - If students sit to view the VR content, will they be able to turn 360 degrees to view all areas of the content if necessary?

As suggested in the accessibility considerations section above, it is highly recommended to test the hardware in conjunction with the software prior to students engaging with the VR activity. For example, the quality of cardboard headsets varies greatly. Lower quality cardboard headsets may cause visual issues (e.g., lenses that are difficult to see through) for individuals that do not have visual impairments. If you are purchasing cardboard headsets for use in class or making a recommendation to your students to purchase one for use at home, test the headset to ensure the lenses are of good quality and do not impair vision. Testing specific VR content while using a cardboard headset with a mobile device will also help identify other challenges (e.g., auto-dimming on the mobile device, determine whether captions can be read) that students may face when engaging in the VR activity. Identifying these issues upfront and sharing these with your students can help reduce barriers and frustration for students.

Another area to test while keeping accessibility in mind is the built-in VR navigation menu. When testing use of the menu to select other VR content while using the cardboard headset, make note of the types of movements this requires (e.g., turning your body and/or head, moving the device to a specific area to locate the menu, hovering over a menu item to select). This may be challenging for students with physical disabilities or motion sickness. Recognizing that the physical movements required to interact with VR may present for some students will help you proactively plan accommodations for students if needed.

Software Considerations

As you search for VR experiences that meet your learning goals, there are several software considerations to keep in mind such as cost, accessibility features, hardware requirements, access, and privacy. Some VR experiences are freely available and don't require students to create accounts to access, while others require students to create an account or pay (e.g., VR mobile application) to access. Whenever students are required to create an account for a third-party tool or install an app on their personal mobile device, privacy should be considered. A few questions to answer when selecting VR software are provided below.

- Is the VR content free to students?
    - If so, will students need to create an account and login to access the free content?
    - If students need to create an account, review the privacy policy.
- Does the web-based VR experience provide accessibility features (e.g., keyboard navigation with arrow keys)?
    - The website or help guide for the VR content may or may not provide information regarding accessibility features.
- Does the VR content provide options for viewing (e.g., view on a laptop via a browser, view in VR mode on a mobile device while using a VR headset)?
    - What hardware is required for students to view the VR content?

Putting it All Together: Use Cases and Examples

The New York Times 360 VR Video

The New York Times 360 VR Video series provides a low-cost way to introduce students to virtual reality and provides flexibility in how students access the content. These immersive videos span a variety of topics and include visual and audio elements that allow students to read text or listen to the unique perspective of a narrator as they interact with and explore the 360-degree video content. One option for students to access these videos is via the 360 VR | The New York Times YouTube channel using a web browser. Students may use the computer mouse to control their view of the 360-degree video. Although this approach is not very immersive, it provides student choice and flexibility regarding the device that is utilized (e.g., laptop, mobile device) and is ideal for students with a disability that limits their ability to hold and/or control a mobile device and a cardboard headset. Encouraging students to use headphones while engaging with this content on a web browser can slightly increase the level of immersion when using this approach (Felder & Proux, 2020). These videos also have closed captions, which students may enable if needed. Although the keyboard arrow keys will not allow students to move the 360-degree video on the screen, the main focus of the content will typically remain on the screen for the student to view while listening to the narrator.

A second and more immersive option for students to access this content is to utilize a mobile device and cardboard headset to view the 360 videos in YouTube. When accessing certain 360 videos in YouTube on a mobile device, a “Spatial Audio” prompt appears informing the user that the video utilizes a new type of sound that is best experienced with headphones. Students with cardboard headsets can tap the VR headset icon on the video in order to view the content in VR mode. Students using a mobile device and cardboard headset may enable closed captions. However, the captions may be difficult to read on a mobile device in VR mode due to the small size of the text on the screen.

The New York Times Virtual Reality Curriculum Guide (https://www.nytimes.com/2020/10/29/learning/lesson-plans/virtual-reality-curriculum-guide-experience-immersion-and-excursion-in-the-classroom.html) offers helpful tips for getting started, lesson plans to use with specific New York Times 360 VR videos, and discussion and reflection prompts for before, during, and after the VR activities.

Roundme

RoundMe.com is a site that has free 360 virtual tours from around the world. These virtual tours consist of one or more still images and may contain text boxes with information to read as you explore. Roundme provides a unique way for students to virtually explore other parts of the world and engage in activities such as comparing two different locations or engaging in a scavenger hunt created by the instructor or student-created scavenger hunts. Students do not need to create an account to access these virtual tours. However, users can create an account in order to create and share a virtual tour on the Roundme site. Locating virtual tours on this site can be accomplished by using the search feature, exploring the "Best New" section, or by utilizing the "World Map" feature to select and zoom in on a specific location. Similar to the NY Times VR Videos, Roundme provides multiple options for students to access the VR content. Students may use a web browser and computer mouse to view and control the content. The keyboard arrow keys may also be used to control the virtual tours, which may be a helpful accessibility feature for some students. Alternatively, students may utilize a mobile device and a cardboard headset to view the virtual tours in a more immersive setting (e.g., VR mode). The virtual tours on this site do not include audio elements; therefore, closed captions are not necessary. Roundme makes it easy to share these virtual tours on other websites by providing embed codes. This provides a lot of possibilities for students to utilize these virtual tours in digital writing and research projects.

VR Apps

There are several VR mobile apps available to explore, test, and determine if they align with your course goals. One challenge with mobile apps is that they come and go or apps may no longer get updates, which could cause issues when using them on certain devices. Testing and vetting apps before using them in the classroom is crucial.

One example of a VR mobile app that helps the user assume a new role/perspective is the "Autism VR Experience" app. This app allows the user to experience firsthand how a child with autism experiences and feels in situations that are overstimulating. VR mobile apps such as this can provide a unique way for students to consider another perspective and learn about specific topics in an immersive environment.

As you search for and explore VR mobile apps, there are a few important things to consider:

- Is the app free or is there a cost?
- Is the app available for both iOS and Android devices?
- Is the app content via a web browser for students who do not have access to a mobile device?
- Will students use shared devices in the classroom, or will they need to use their own devices?
    - If students will use their own mobile device:
        - How much space will they need to have on their device to install the app?
        - Do they have the permissions on the device they will use (in the situation where a student borrows a phone)?
        - Are there privacy concerns with the app?

- When was the app last updated?
    - Apps that have not been updated in several years may not perform well.
- Does the app provide any accessibility features?

Conclusion

As presented in this paper, access to low-cost VR hardware and software has increased, making it easier for educators to utilize this technology with students. While this technology will continue to evolve, the accessibility considerations presented in this article will remain relevant. In addition to considering accessibility, it is important to also remain focused on the learning goals and purpose for including VR in the curriculum rather than first focusing on the technology. Testing the technology with accessibility in mind and intentionally designing the learning experiences are key. Once appropriate VR technologies have been identified and meaningful learning experiences have been designed, all students, including those with special needs, can engage with and benefit from the use of VR.

References

Agullo, B., Montagud, M. & Fraile, I. (2019). Making interaction with virtual reality accessible: rendering and guiding methods for subtitles. *AI EDAM, Intelligent Interaction Design* 33(4). pp. 416 – 428. DOI: https://doi.org/10.1017/S0890060419000362

Almedia, F. (2020, November 10). What are Haptics? *Immersion*. Retrieved November 4, 2021 from https://www.immersion.com/ja/what-are-haptics/

Butt, A., Kardong-Edgren, S., Ellertson, A. (2018). Using Game-Based Virtual Reality with Haptics for Skill Acquisition. Clinical Simulation in Nursing, Volume 16, pages 25-32. https://www.sciencedirect.com/science/article/pii/S1876139917301986

Caddy, B. (2016). Vomit Reality: Why VR makes some of us feel sick and how to make it stop. *Wareable*. Retrieved November 4, 2021 from https://www.wareable.com/vr/vr-headset-motion-sickness-solution-777

Feldler, T. & Proulx, N. (2020, October 29). The New York Times Virtual Reality Curriculum Guide. The New York Times. Retrieved September 1, 2021, from https://www.nytimes.com/2020/10/29/learning/lesson-plans/virtual-reality-curriculum-guide-experience-immersion-and-excursion-in-the-classroom.html

Jowallah, R., Bennett, L., & Bastedo, K. (2018) "Leveraging the Affordances of Virtual Reality Systems within K-12 Education: Responding to Future Innovations," *FDLA Journal*. Vol. 3, Article 7. Available at: https://nsuworks.nova.edu/fdla-journal/vol3/iss1/7

Liagkou, V., Salmas D., & Stylios, C. (2019). Realizing Virtual Reality Learning Environment for Industry 4.0. Procedia CIRP, Volume 79, Pages 712-717. https://doi.org/10.1016/j.procir.2019.02.025.https://www.sciencedirect.com/science/article/pii/S2212827119301398

Mott, M., Cutrell, E., Gonzalez Franco, M., Holz, C., Ofek, E., Stoakley, R., & Ringel, M. (2019). Accessible by Design: An Opportunity for Virtual Reality. 2019 IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMAR-Adjunct, Beijing, China. https://www.microsoft.com/en-us/research/uploads/prod/2019/08/ismar_mra_workshop_microsoft_final_draft.pdf

Mott, M., Tang, J., Kane, S., K., Cutrell, E., & Morris, M. R. (2020). "I just went into it assuming that I wouldn't be able to have the full experience." Understanding the accessibility of Virtual Reality for people with limited mobility. Assets '20: The 22 International ACM SIG ACCESS Conference on Computers and Accessibility. Article Number 43. Pages 1-13. https://dl.acm.org/doi/10.1145/3373625.3416998

Saredakis D., Szpak, A., Birckhead, B., Keage, H., Rizzo, A., & Loetscher, T. (2020, March 31). *Factors Associated With Virtual Reality Sickness in Head-Mounted Displays: A*

Systematic Review and Meta-Analysis. Frontiers in Human Nueroscience. Retrieved (date) from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7145389/

Siu, A., Sinclair, M., Kovacs, R., Ofek, E., Holz, C., & Cutrell, E., (2020). *Virtual Reality Without Vision: A Haptic and Auditory White Cane to Navigate Complex Virtual Worlds*. Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems, April 25–30, Honolulu, HI, USA. https://www.microsoft.com/en-us/research/uploads/prod/2020/02/Siu-VR_without_vision-CHI2020.pdf

Veličković, P., & Milovanović, M. (2021). Improvement of the Interaction Model Aimed to Reduce the Negative Effects of Cybersickness in VR Rehab Applications. *Sensors (Basel, Switzerland), 21*(2), 321. https://doi.org/10.3390/s21020321

Yakubova, G., Kellems, R. O., Chen, B. B., & Cusworth, Z. (2021). Practitioners' Attitudes and Perceptions Toward the Use of Augmented and Virtual Reality Technologies in the Education of Students With Disabilities. *Journal of Special Education Technology*. https://doi.org/10.1177/01626434211004445

Zhao, Y., Cutrell, E., Holtz, Christian, Morris, M R., Ofek, E., & Wilson, A.D. (2019). *SeeingVR: A Set of Tools to Make Virtual Reality More Accessible to People with Low Vision*. Proceedings at the 2019 CHI Conference, May 4-9, Glasgow, Scotland, UK. https://www.microsoft.com/en-us/research/uploads/prod/2019/01/SeeingVRchi2019.pdf