Augmented Reality, an Educational Tool

IS390 – IS Reading and Research

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**Introduction**

The developing and expanding technology of Augmented Reality (AR) is primarily known for its ability to superimpose digital objects or data on to the physical world, enabling the interaction between the end-user and the parallel existing digital objects and the tangible physical world. Augmented reality has attracted quite a bit of attention in recent times due to the vast potential of this technology to enhance different sectors, including career and trade-related instruction along with primary and secondary education. Augmented reality technology presents an extraordinary way of attaining knowledge by giving the user a deeply interactive and immersive learning experience. This immersive learning environment using AR technology can greatly enhance the user’s comprehension of the presented information along with augmenting the user’s potential to retain that information for future use.

This study will strive to investigate the utilization of Augmented reality as an instructional tool for job training and formal education. The primary emphasis of this study will be placed on the potential advantages and disadvantages of the implementation of this technology. Additionally, the secondary purpose of this study is to highlight some of the current uses of this technology and present through overview of augmented reality technology and its potential to transform the realms of education and training.

**What is Augmented Reality (AR)? How does it differ from Virtual Reality (VR)**

One of the seemingly most common things to happen in the English language is to take two things whose function is very similar but distinctly not the same and use the terms interchangeably; this has happened to a very large extent with AR and VR. In some cases, this is due to a lack of in-depth knowledge of the two items and to that end this section is going to try to explain the difference between augmented reality and Virtual Reality.

The dictionary at merriam-webster.com defines augmented reality as “an enhanced version of reality created by the use of technology to overlay digital information on an image of something being viewed through a device” (*Definition of AUGMENTED REALITY*, 2023). To augment that a report created by the Naval Research Laboratory in Washington DC defined augmented reality as “an AR system supplements the real world with virtual (computer-generated) objects that appear to coexist in the same space as the real world” (*Recent Advances in Augmented Reality*, n.d.) and goes on to say that an augmented reality system needs to combine real and virtual objects in the real world, runs interactively in real time, and aligns real and virtual objects with each other in order to be considered a true AR system. One of the key takeaways from these pieces of information is that AR needs to interact with the real world which as we will soon see is something that is not needed with virtual reality systems.

Like with augmented reality, let us start with the dictionary definition of the term. According to the dictionary at merriam-webster.com, the definition of virtual reality is “an artificial environment which is experienced through sensory stimuli (such as sights and sounds) provided by a computer and in which one’s actions partially determine what happens in the environment.” (*Definition of VIRTUAL REALITY*, 2023). This definition backs up the majority of the definitions found in the article What is Virtual Reality? A healthcare-focused systematic review of definitions. This article published in March of 2023 goes into an in-depth comparison of the terms surrounding virtual reality in the medical field. One such definition was quoted as “Virtual reality (VR) can be defined as an approach to user-computer interface that involves real-time simulation of an environment, scenario or activity that allows for user interaction via multiple sensory channels.” (Adamovich SV, 2009, “What Is Virtual Reality?,” 2023). As you can see in both definitions the key feature of virtual reality is that it is just that, virtual, or a simulation.

There are many other differences between virtual reality and augmented reality but the primary one that users need to be aware of is: Virtual reality isolates the user from their physical environment while augmented reality tries to maintain the user’s connection to the real world. Especially if you are selecting between an augmented or virtual reality training or education program, it might be vital to your selection.

**How does AR work?**

At this point it is well established that augmented reality overlays digital information on top of the physical environment that is around the user. How this works is very technical, and an in-depth understanding is not really necessary for the overall understanding of this papers’ topic but for sake of completion we will include a shortened explanation of how augmented reality devices work.

Let us divide this explanation into three parts Sensing the real world, overlaying virtual content, interaction and display.

There are many different types of augmented reality apps out there, location-based, marker-based, marker-less, superimposition-based, and simultaneous localization and mapping (SLAM). For the purposes of this explanation, we will look at SLAM as the other types take parts of SLAM. For an augmented reality device to sense the world around it, the device relies on many different sensors to get an understanding of the world. Some of these sensors can include cameras, GPS, depth sensors, and gyroscopes. These components gather data about the environment that the user is in to tell the user’s exact position and orientation along with the movement of any objects. In an article titled Parallel Tracking and Mapping for Small AR Workspaces by Klein, AR systems are reliant on simultaneous localization and mapping (SLAM) algorithms to keep track of the user’s location and orientation in real time. (Klein & Murray, 2007) Basically, the data gathered creates a map of the user’s environment and then the device estimates the location of the user within that map.

The next step is overlaying virtual content. When the augmented reality device has finished mapping the user’s environment and the user’s position in it, then the device can begin to overlay the virtual content onto the real-world environment. In their article Collaborative Augmented Reality, Billinghurst and Kato describe how augmented reality systems recognize distinctive parts of the user’s environment or specific objects in that environment to place and align the virtual content (Billinghurst & Kato, 2002).

The final step is allowing the user to interact with the virtual content; this is done using various types of display devices from head mounted displays to tablets and phones. In an article titled A Survey of Augmented Reality Technologies, Applications, and Limitations Krevelen and Poelman talk about the diverse array of optical displays and interactivity devices that allow the user to experience the digital content in that augmented reality session (Krevelen & Poelman, 2010).

**Uses of AR and VR in professional training**

Augmented reality technology demonstrates various applications in job training across a wide range of professional fields. These can encompass the augmenting of tried-and-true conventional methods and more innovative and modern techniques. The use of augmented reality allows trainees to engage in realistic simulations manipulating virtual objects from within an environment that is both secure and monitored to maximize the trainee’s learning experience and ensure that the trainee’s training environment is safe.

There are so many possibilities with augmented reality in professional training that they are almost limitless. You have industrial training and maintenance, where your trainees could be provided hands on training allowing them to practice tasks and trouble shoot issues by following directions that are right in front of them in the virtual content of the training program. Another field that benefits greatly from using this technology is the military and law enforcement. Augmented reality and virtual reality are used to train military and law enforcement personnel in tactical decision making and situational awareness by providing realistic simulations of combat situations and emergency response scenarios. This technology can also be used to train interpersonal skills and empathy by having the trainees interact with virtual characters and receive feedback on performance, which is a vital part of nursing or mental health care personnel. A journal article published in the Advances in Simulation states “Greater empathy in nursing is linked with reduced restrictive practices in inpatient services and reduced conflict between staff and service users” (Riches et al., 2022). This would be a good skill that could be learned by any personnel in the customer service industry.

One of the primary professions to embrace augmented reality as a training aid has been the medical professions. Historically, surgeries have been conducted through large open incisions, but in modern medicine laparoscopic surgery is the accepted method to deal with many disorders and diseases. Because this type of surgery is conducted through incisions in the pelvis or abdomen it requires very specialized equipment and a highly trained surgeon. According to Botden and Jakimowicz in their journal article What is going on in augmented reality simulation in laparoscopic surgery? There are three main ways that a laparoscopic surgeon gets the training that they need in order to perform surgery. A traditional box trainer, virtual reality, and augmented reality. Box trainers “lack objective assessment of performance” (Botden & Jakimowicz, 2009), virtual reality trainers “assess performance, but lack realistic haptic feedback” (Botden & Jakimowicz, 2009), but augmented reality “combines a virtual reality setting with real physical materials, instruments, and feedback” (Botden & Jakimowicz, 2009) thus giving the surgeon a realistic environment in which to hone their skills.

**Uses of AR in an educational setting**

Your choice of augmented or virtual reality in the context of the classroom setting has much to do with what do you want to teach with it. The two technologies have close to the same capabilities though each has a distinct strength that is better for some learning experiences than others.

Augmented Reality’s role in formal education can get off to a semi rocky start, due primarily to the initial cost of procurement of the equipment and apps on limited budgets. According to an article on wear-studio.com called Cost-of-Augmented-Reality (Boiko, 2022) there are many factors that control the cost of development of an augmented reality app which has a drastic effect on the cost of a classroom augmented reality set up. The type of augmented reality that you want to have, marker, marker-less, Superimposition-based, or SLAM. The content and complexity of the app play a pretty big role also and then there is the software licensing. Boiko states that “a simple AR application will cost from $7000 to $50,000 to develop” (Boiko, 2022), with apps that are more complex in structure, and content you would be spending around $200,000 (Boiko, 2022). It really depends on what the educator wants to do with the app and the budget that the school has.

The institutions that have the ability and means to acquire access to augmented reality equipment and apps have steadily applied the technology with the goal of providing their students with fascinating and interactive learning environments. Augmented and virtual reality devices offer a unique avenue for teaching skills to people in an education setting. In an article called The 70:20:10 Framework and The Transfer of Learning (Johnson et al., 2018) Johnson explores the concept that human beings learn things by combining three types of learning: hands on or doing (70%), social or learning from society (20%), and formal or learning from a educational institution (10%). Augmented Reality technology offers educators a new tool to use to convey complicated and detailed information through an instinctive and hands on approach. As with the use of augmented and virtual reality in professional training the uses are almost limitless. In his article Augmented Reality in Education and Training (Lee, 2012) Kangdon Lee states that in college and university level education augmented reality is being used to help students in the studies of astronomy, chemistry, biology, and physics. He goes on to describe how this technology brings even textbooks to life by having 3D pop up scenes and more in-depth information be available through the use of the AR device. This instructional technique can be instrumental in assisting with the student’s comprehension and retention of the before mentioned complex and detailed concepts by providing a safe, highly immersive, and interesting learning environment where the student can interact with subject related virtual objects in ways that were not available to educators in previous generations.

**Conclusion and recommendations**

So, in conclusion, we have introduced you to the concept of augmented reality. We gave a comparison of the augmented and virtual reality technologies along with a heads-up that many people and organizations tend to use the terms AR and VR interchangeably even though they are different technologies. We provided a high-level explanation of how augmented reality equipment works and gave some examples of how augmented reality is used in professional career training and how it is used in formal education arenas. As augmented reality is not the only technology that can be used in these areas of instruction it is my recommendation that a study be done into virtual, and mixed realities and their uses in training and education.

**Bibliography**

Billinghurst, M., & Kato, H. (2002). Collaborative augmented reality. *Communications of the ACM*, *45*(7), 64–70. <https://doi.org/10.1145/514236.514265>

Boiko, O. (2022, August 14). How Much Does Augmented Reality Cost + Examples. *WeAR*. <https://wear-studio.com/cost-of-augmented-reality/>

Botden, S. M. B. I., & Jakimowicz, J. J. (2009). What is going on in augmented reality simulation in laparoscopic surgery? *Surgical Endoscopy*, *23*(8), 1693–1700. <https://doi.org/10.1007/s00464-008-0144-1>

*Definition of AUGMENTED REALITY*. (2023, April 29). <https://www.merriam-webster.com/dictionary/augmented+reality>

*Definition of VIRTUAL REALITY*. (2023, April 30). <https://www.merriam-webster.com/dictionary/virtual+reality>

Johnson, S. J., Blackman, D. A., & Buick, F. (2018). The 70:20:10 framework and the transfer of learning. *Human Resource Development Quarterly*, *29*(4), 383–402. <https://doi.org/10.1002/hrdq.21330>

Klein, G., & Murray, D. (2007). Parallel Tracking and Mapping for Small AR Workspaces. *2007 6th IEEE and ACM International Symposium on Mixed and Augmented Reality*, 1–10. <https://doi.org/10.1109/ISMAR.2007.4538852>

Krevelen, D. W. F. van, & Poelman, R. (2010). A Survey of Augmented Reality Technologies, Applications and Limitations. *International Journal of Virtual Reality*, *9*(2), Article 2. <https://doi.org/10.20870/IJVR.2010.9.2.2767>

Lee, K. (2012). Augmented Reality in Education and Training. *TechTrends: Linking Research & Practice to Improve Learning*, *56*(2), 13–21. <https://doi.org/10.1007/s11528-012-0559-3>

*Recent Advances in Augmented Reality*. (n.d.). Retrieved May 30, 2023, from <https://apps.dtic.mil/sti/citations/ADA606245>

Riches, S., Iannelli, H., Reynolds, L., Fisher, H. L., Cross, S., & Attoe, C. (2022). Virtual reality-based training for mental health staff: A novel approach to increase empathy, compassion, and subjective understanding of service user experience. *Advances in Simulation*, *7*(1), 19. <https://doi.org/10.1186/s41077-022-00217-0>

What is Virtual Reality? A healthcare-focused systematic review of definitions. (2023). *Health Policy and Technology*, 100741. <https://doi.org/10.1016/j.hlpt.2023.100741>