Experiential Learning Through Virtual Reality in Science Education

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Abstract

Virtual reality offers the affordance of a real-world experience engaging learners in a wholly immersed reality, allowing the brain to better absorb material for making the connection of knowledge acquired to the real world. It is indispensable to experience the task or event through myriad modalities and appeal to a broader audience of learners. Therefore, educators can transform learning through this new modality, disseminating knowledge in ways never imagined before. However, the utilization of virtual reality in the education sector is lagging. Lastly, experiential learning ensues as the gap between acquiring knowledge and assimilating learning in a realistic environment decreases with an immersive virtual reality experience. The purpose of this research is to bring awareness to technology that is available to harness a student's learning. With the introduction of virtual reality, it is the purpose of this study to maintain students' interest in space science, entice creative thinking, and galvanize students into becoming innovators that foster their own learning. This study aims to suggest that immersive virtual reality integration will impact learning by increasing learner retention and maintaining interest.

Keywords: VR integration, VR K-12, VR middle school education, experiential learning, VR, immersive learning

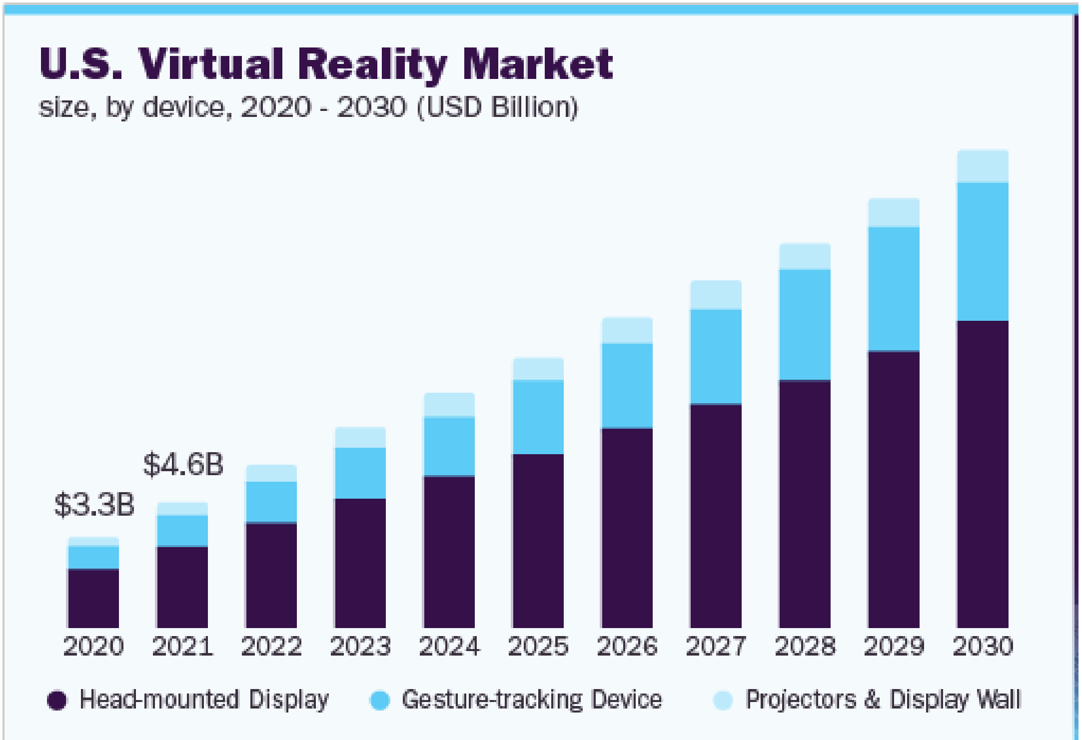
Experiential Learning Through Virtual Reality in Science Education

Science and technology fields are expeditiously advancing. Although virtual reality technology first emerged in 1968 in the form of a head-mounted display created by Ivan Sutherland and Bob Sproull (Cooke, 2017), in its present state, it has far exceeded what anyone could have imagined. In this new environment, individuals are envisioned to adapt alongside these changes resulting in industries having an expectation of a more diversified individual encompassing skills such as virtual collaboration skills, creativity, critical thinking skills, and problem-solving skills (Davies et al., 2011). Creating autonomous learners who work in an adaptable multifaceted environment should be one of the main focuses of educators today. Not only focusing on one diacritic skill but equipping learners with an abundance of skills.

The market size for virtual reality is growing exponentially in the United States and globally. Grand View Research (2022) reported a market value of 28.42 billion in 2022 with expected growth of 87 billion in 2030, a 15% growth rate from 2022 to 2030. Compared to 2021, when the virtual reality market was valued at 21.83 billion (Grand View Research, 2022). Grand View Research (2022) compares the three different types (head-mounted displays, gesture-tracking devices, and projectors and display walls) of virtual reality and their projected growth from 2022 to 2030, shown in Figure 1. In 2021, head-mounted displays account for the greatest increase with over 60% and are forecasted to preponderate the market.

Figure 1

Comparison of VR Display

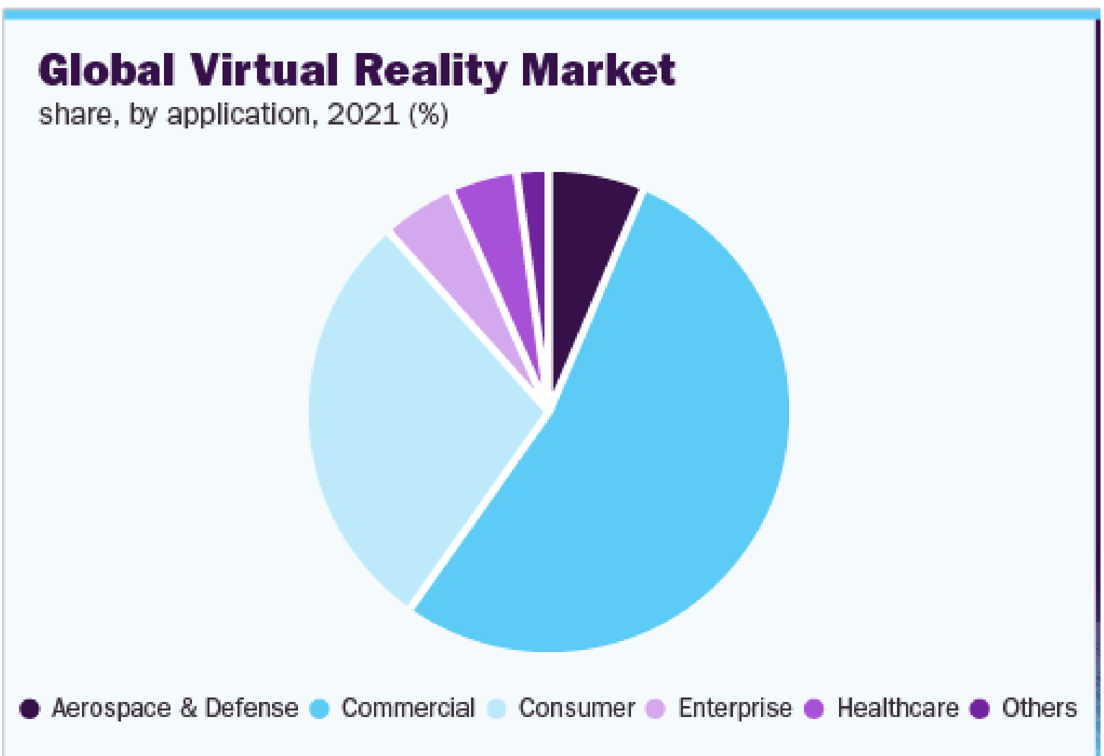


Note. The largest projected growth is for head-mounted displays

Virtual reality as a digital platform is also increasing its presence in many sectors as a training tool for automotive, defense, finance, healthcare, emergency services, logistics, offshore, and aviation (Nijland, 2020) including companies such as Rolls-Royce (*Press Releases* | *Rolls-Royce - Rolls-Royce Launches First Immersive Virtual Reality Training for Business Aviation Customers*, 2020), Lufthansa (*VR Flight Training: Lufthansa Avsiation Training & NMY* | *Ultraleap*, 2022), ExxonMobil (Daughtry, 2019), JetBlue, Boeing, UPS, Walmart (Morris, 2018), Confideo Labs, Best Western, MHI Vestas, Fidelity Investments, Bechtel (Creighton, 2018b), Walmart, UPS, Ford Motor Company, Kentucky Fried Chicken (Creighton, 2018a). Figure 2 depicts the growth across six such industries showing the most adoption in the commercial sector. VR technologies are increasingly being sought after by higher education institutions as a means of innovative online teaching and learning, although the entertainment and gaming industries still hold the largest market share (Wohlgenannt et al., 2020). Unfortunately, one entity that has been missing from the conversation is K-12 education. Despite the fact that virtual reality has immense potential and is used in every other sector, K -12 education is a sector lacking in virtual reality use which can help with learner retention, learner engagement, learners grappling with new concepts, and learners making the connection from classroom to the real world.

Figure 2

Global Virtual Reality Market



Note. *Market dissected by application*

As a pedagogical method, computer-aided education is not a recent development, and studies examining its effectiveness have been conducted for more than half a century. Ellinger and Frankland (1976) discovered that using early computers to teach economic principles yielded comparable learning outcomes to traditional didactic approaches such as lectures as early as the 1970s. On the other hand, according to Jensen and Konradsen (2018), with the emergence of the Oculus Rift in 2013, virtual reality became associated with a head-mounted display (HMD) based virtual reality. Nonetheless, one of the most significant contributions of virtual reality to education has been the ability to repeatedly practice intricate and onerous activities in a safe setting.

In a study by Krokos, Plaisant, and Varshney (2019) the primary aim was to investigate if participants learned better in a virtual environment vs. traditional platforms such as desktop computers or tablets. Their primary focus was to test and see if VR impacts a person's recollection capacity. The participants were immersed in a "memory palace," in which they recall an object or item by placing it in an illusory physical area. Researchers used spatial mnemonic encoding to convey information in this style, which refers to the brain's capacity to arrange ideas and memories in layman's words spatially. Krokos et al. (2019) discovered that using a VR application improved participants' memory capacity by at least 10%. While this figure may appear modest, researchers report that it was statistically significant and not due to chance. The ability to envision and observe in an immersive environment was vital to this enhancement in memory rates. This occurs because, through VR, the engagement provides users a genuine sense of entering a scene and allows them to construct their own digitally lived experiences. It is the act of enhancing learning and memory by exploiting a person's innate capacity to detect position of the body, motion, and acceleration.

Literature Review

In today's generation, immersive technologies swiftly pique and maintain our learners' interest in a multitude of ways within middle school education. Learners are now able to accomplish learning with technologies such as virtual reality (VR). In virtual reality, physical and digital objects co-exist in real-time and interact, creating new settings and visuals. The fusion of the actual and virtual worlds is referred to as hybrid reality (Liou & Chang, 2018).

Correspondingly, Zheng et al. (1998) stated, "Virtual reality (VR) is an advanced, human-computer interface that simulates a realistic environment. The participants can move around in the virtual world" (p. 20). Virtual reality allows users to view many aspects of the world from diverse perspectives. The virtual environment allows users to experience various elements as if they were right there. Virtual reality may be thought of as an augmented simulation of learning that allows the user to feel a near-reality immersion in the topic at hand. Virtual reality field trips are a perfect example. Integrating e-learning, defined as "electronically mediated asynchronous and synchronous interaction to build and confirm knowledge" (Garrison, 2016, p. 2), has been found to promote learning through active engagement rather than passive participation (Fletcher et al., 2007). Educators can augment learning experiences by offering virtual field trips to ancient civilizations, museums, spacewalks in the International Space Station, wildlife exploration, ocean exploration, and traversing the human body from the inside out to acquire new abilities and insight through novel learning techniques. According to Stainfield et al. (2010), virtual field trips require a blend of old and new methods to be successful, allowing for participation and exploration of the environment while still developing skills associated with those methods.

In contrast to traditional education, Durbin (2016) found that virtual reality-based education has shown clear advantages in facilitating the acquisition of both theoretical knowledge and practical skills. Using theoretical knowledge, education is capable of bringing concrete effects to abstract issues. In addition, by bringing the classroom to life, it improves students' operational skills, provides a holistic learning experience, and fosters their sense of engagement in class, making learning more interactive, entertaining, and safe.

Similarly, Lacko (2019) conducted research that found a substantial difference between two groups of students learning the same topic, where one group utilized virtual reality and the other did not. The study discovered that students who used virtual reality received a greater percentage of accurate responses right away than those who did not. Furthermore, the same study discovered that students who used virtual reality improved considerably after one week and one month. After one month, students who used virtual reality had 71% accuracy relative to those who did not use virtual reality, with 52% correct responses. Using technology, education can be reoriented away from learning discrete facts and developing rich and productive knowledge (Gerard et al., 2017).

Evolution of Virtual Reality

There has been much dispute of the timeline of virtual reality and what has constituted as virtual reality. According to the Virtual Reality Society (n.d.) it has been suggested that the earliest panoramic paintings, created in the early nineteenth century, may be considered a form of virtual reality since they were meant to encompass the viewer's whole field of vision, giving the impression that they were there at the site of the image. As indicated by the Virtual Reality Society (n.d.), in 1838, the first stereoscope was researched by Charles Wheatstone. Through Wheatstone's research, it was discovered that the brain could take a two-dimensional image and turn it into a three-dimensional object. Using two stereoscopic pictures, viewers might thus have a sensation of depth and immersion. In 1956, the next momentous advancement in virtual reality occurred. The Sensorama was created by Morton Heilig and was dubbed "The Cinema of the Future" (Heilig, 1992, p. 240). Heiling (1992) stated, "through a combination of ingenuity, determination, and sheer stubbornness was the first person to attempt to create what we now call virtual reality" (Heilig, 1992, p. 240). Sutherland (1965) stated:

> "The ultimate display would, of course, be a room within which the computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal. With appropriate programming such a display could literally be the Wonderland into which Alice walked." (p. 508)

In 1965, Ivan Sutherland created what looks more like a head-mounted display of virtual reality headsets. His imagination and vision was the foundation for the virtual reality immerging today.

As virtual reality became more affordable in the 1990s, it culminated in the 1995 release of the Nintendo Virtual Boy, which offered immersive headsets and suits for enterprises and businesses. In addition, we have seen many advances in virtual reality from the Google Cardboard, Oculus, and HTC Vive.

Virtual Reality and Education

Educational technology has become more affordable and ubiquitous, revolutionizing how students interact with educators and acquire knowledge about the world around them (Dunleavy et al., 2009; Huang et al., 2019). The integration of virtual reality into the educational school system allows for a plethora of possibilities, including increased learner involvement, greater comprehension, increased competency, and learners taking charge of their learning. In addition, virtual realities are utilized for enhanced visual and interactive forms of learning, increasing learner retention chances. This added contextual layer allows the learners to connect between their lives, education, and reality.

"Educational technology is a complex, integrated process involving people, procedures, ideas, devices and organization for analyzing problems and devising, implementing, evaluating and managing solutions to those problems involved in all aspects of human learning" (Force, 1977, p. 1). As such, the Association for Educational Communication and Technology (AECT) asserted that educational technology plays a vital role in the learning process since it assimilates various facets and requires contributions from individuals and the community at large.

Allowing learners to interact through virtual reality allows them to construct new learning and understanding, bringing the objects and subjects being studied to life. Learners are permitted to manipulate artifacts with their own hands in the VR-created situated learning environment and carefully investigate and experience them (Liou &

Chang, 2018). Virtual reality enhances the activities in which the learner engages, immersing them in entirely and expanding their attention, allowing for various interactions, and ultimately taking responsibility for their education.

Educational institutions are progressively adopting digital devices to improve teaching and learning (Zawacki-Richter & Latchem, 2018). This was observed during the era of collaborative learning and when digital learning became widely available online. As a result, individuals investigated the possibility for the utilization of developing technologies such as virtual learning environments (Boulton et al., 2018; Muñoz-Cristóbal et al., 2017), making it possible to connect through the use of devices such as computers (Mason & Bacsich, 1998), and portable devices such as a phone (R. Wang et al., 2012). Virtual reality is the newest pedagogical technology to be utilized in education (Prinsloo & Van Deventer, 2017).

As learners' digital fluency increases, incorporating prevalent media such as immersive interfaces in virtual reality can help design the learners' educational experience. Significant benefits for educating learners in the VR landscape include improved motivation and retention, a high level of interactivity and collaboration for interpersonal development, the promotion of active and experiential learning, and leveraged exposure of practical skills to deal with real-world demands. Therefore, this experience promotes increased brain learning stimulation to absorb learning better and emulate the real world, providing learners with an authentic learning experience through the use of innovative social communication tools, visualization tools, and simulation tools (Chang et al., 2010).

Historically, virtual reality has been integrated into many industries, which affirmed the effectiveness it has on optimizing practical and technical expertise within fields including control of an aircraft (Wang et al., 2019), art (Huang et al., 2019), chemistry (Isabwe et al., 2018), operation of an excavator (Sekizuka et al., 2019), sports (Gómez-García et al., 2018), medicine (Mazurek et al., 2019), forklift operator (Lustosa et al., 2018) and engineering (Liarokapis et al., 2004). Aviation and military forces are two industries that have reaped the benefits of virtual reality. Virtual reality has been developed and integrated into these industries as a training mechanism for soldiers and, respectively, flight simulators for pilots. Lele (2011) emphasized the significance of virtual reality technology in military training. Training in a virtual reality environment allows minimum exposure to potentially perilous circumstances in a safe setting, like running into a fire (Backlund et al., 2007; Conges et al., 2020) and explosions and natural disasters (Li et al., 2017) for firefighters.

Virtual reality drastically reduces the cost of training soldiers and pilots and allows for a plethora of scenarios to take place in a safe environment. Virtual reality technology also enables trainees to learn in the privacy of their own homes or where they are most comfortable. In addition, trainees are able to test multiple actions in controlled environments, better preparing them for the real-world experience. Furthermore, reaffirming the importance of virtual reality in military training throughout the world, a 2003 Hague report by NATO , Virtual Reality: State of Military Research and Applications in Member Countries, stated, “The key to the effectiveness of virtual reality for military purpose is the man-machine interface or human-computer interaction. Military personnel must be able to perform their tasks and missions using VR sensory display devices and response devices" (p. T-2). Since these industries have seen success through the integration of virtual reality, it is further evidence that virtual reality can enhance the educational industry the same.

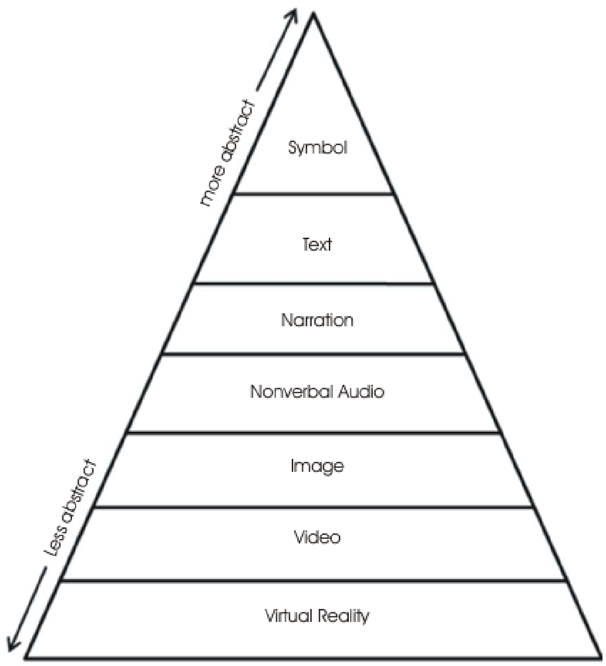
The Theory of Cone of Experience (CoE) was developed by Dale (1946, 1969) to ascribe that students retain 10% of what they read, 50% of what they see and hear simultaneously, but interestingly retain 90% if they visually see and physically carry the action out simultaneously. Dale theorized that students will learn and will be able to retain more information by what they do versus by what they see, read, or hear. In 2013 the Theory of Cone of Experience (CoE) was revised by Baukal et al. (2013) presented as the Multimedia Cone of Abstraction (MCoA) (Figure 1). Dale's theory was valid and beneficial for his era but fell victim to technology. The Multimedia Cone of Abstraction (MCoA) used Dale's theory as a basis and integrated virtual reality into the theory. Baukal et al. (2013) explained the Multimedia Cone of Abstraction as:

> The closer to the bottom of the cone, the more realistic the representation; the closer to the top, the more abstract. The choice of a cone helps symbolize that multimedia towards the bottom is likely to be effective for more learners, compared to the top where fewer learners possess the knowledge and experience needed to process information in those forms. (p. 19)

Therefore, placing an immersive experience through virtual reality would be placed at the bottom of the cone.

Figure 1.

Multimedia Cone of Abstraction (MCoA)



According to Richtel (2012), increasing reliance on technology has transformed the way learners acquire and absorb information stating, there is emerging evidence that regular use of technology might impact behavior, particularly in developing brains, due to high stimulation and abrupt shifts in attention. The new era of learners with technology readily available at their fingertips has shifted the way information is processed.

Learners have experienced learning in various facets, including portfolio systems, video creating platforms, learning management systems, gaming apps, blogs, laptops, smartphones, iPads, to name a few. Of all of the technologies incorporated into the classroom, nothing equates to implementing virtual reality. “Interactive multimedia, in particular, provides a powerful tool for both teachers and learners in the design of environments which enables learner learning” (Semple, 2000, p. 21). Educational theories maintain that knowledge is something that is built actively through real-world interactive experiences, not something that is passively absorbed.

Christensen and Knezek (2008) developed a technology implementation measurement instrument. According to their research, technology in the classroom is most effective when the educators are professionally trained, and the initiative is well supported by the administration. Through the sustained use of educational technology, Christensen and Knezek (2008) reported significant improvements in student learning and attitudes toward school upon focusing on educational technology. According to Christensen and Knezek (2008), education technology is defined as an interdisciplinary study that examines the process of analyzing, developing, implementing, and evaluating the instructional environment and learning materials with the aim of improving teaching and learning.

Merchant et al. (2014) focused on the effectiveness of virtual reality and what impact it has on student learning outcomes and found “games (FEM = 0.77; REM = 0.51), simulations (FEM = 0.38; REM = 0.41), and virtual worlds (FEM = 0.36; REM = 0.41) were effective in improving learning outcome gains” (p.29). In addition, results from the study showed that “Eight of the studies (62%) showed statistically significant positive effects (i.e., game-based instruction increased learning outcome gains” (Merchant et al., 2014, p. 34).

According to another study, Chen et al. (2012) sustained that learning through virtual reality “makes their learning become much more interesting, amazing and motivating. It provides students with a vivid, rich, varied and realistic learning environment. Students are changed into real participators in the virtual environment” (p.

1217-1218). In research conducted by Chen et al. (2007), the findings for the pre-test and post-test with the usage of virtual reality were statistically significant; nonetheless, it supported the hypothesis that virtual reality could assist sixth-grade students to develop a better grasp of astronomy.

Technology integration into the educational system offers an endless amount of possibilities. With the integration of virtual reality, the possibilities increase exponentially. Virtual reality brings subjects to life. Engaging in the activities in immersive environments requires students to become active participants as they move around and engage in the activities. Within the virtual environment, students turn and look in every direction, move around, use their arms, legs, heads, neck, eyes, and so much more. Madathil et al. (2017) attributed the potential of virtual reality to "reduce costs, allow students to interact with unobservable phenomena, increase perceived learning outcomes, and increase student engagement" (p. 8).

Immersive Learning

Traditional learning is swiftly becoming outdated. As learners embrace new technologies faster than their teachers, it is a challenge for teachers to remain relevant. A new generation of learners requires immersive, interactive, and hands-on teaching methods that appeal to them directly. "VR eliminates the traditional separation between user and machine, providing more direct and intuitive interaction with information" (Bricken & Byrne, 1993, p. 199). Learners who are gamers and utilize such platforms may find it challenging to learn in the traditional classroom. Therefore, implementing virtual reality, learners "can learn in a quick and happy mode by playing in the virtual environments" (Pan et al., 2006, p. 20). Virtual reality "allows a new type of learning that better meets the needs of the 21st-century learner who wants entertainment, interactivity, participation, and manipulation of objects” (Elmqaddem, 2019, p. 235). Subject areas that were once difficult to understand, now with the use of “these applications show that VLE [virtual learning environments] can be means of enhancing, motivating and stimulating learners’ understanding of certain events, especially those for which the traditional notion of instructional learning have proven inappropriate or difficult” (Pan et al., 2006, p. 25).

Other “studies have shown that immersion in a digital environment can enhance education in at least three ways: by allowing multiple perspectives, situated learning, and transfer” (Dede, 2009, p. 66). Situated learning happens when learners are placed in that environment or situation and can learn how to maneuver through the situation at hand. Unfortunately, situated learning is not feasible for all learners or classrooms. Research of this enhanced technology helps us understand “the potential advantage of immersive interfaces for situated learning [such as] … their simulation of real-world problems and contexts that learners must attain only [through] near-transfer to achieve preparation for future learning” (Dede, 2009, p. 67). That “immersion may enhance transfer through simulation of the real world” (Dede, 2009, p. 67). What the integration of virtual reality does is allow “immersive interfaces [to] … draw on the power of situated learning by enabling digital simulations of authentic problem-solving communities in which learners interact with other virtual entities (both participants and computer-based agents) who have varied levels of skills” (Dede, 2009, p. 66).

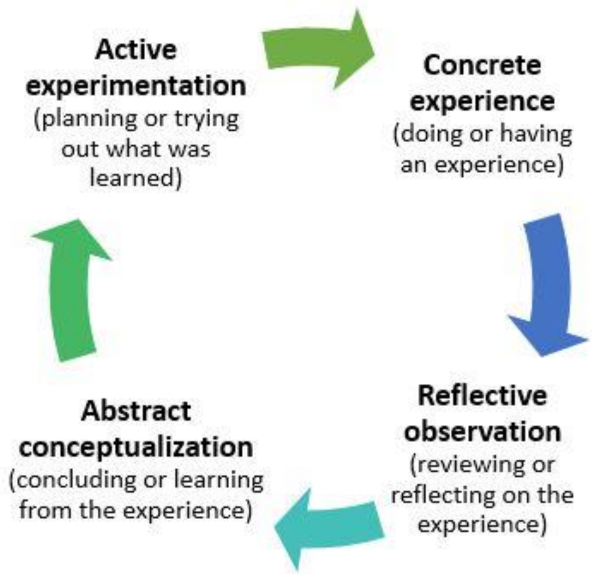
Research on the potential positive side effects of virtual reality technology, when implemented correctly, has shown to “reduce the cognitive load for learners while increasing motivation and interest towards the course material” (Adžgauskaitė et al., 2020, p. 280). In addition, some of the benefits of integrating virtual reality are that virtual reality “offers experiential learning opportunities that help students engage concepts and challenges in personalized educational environments” (Adžgauskaitė et al., 2020, p. 280). Adžgauskaitė et al. (2020) go on to further state that “the key benefit of adopting VR’s experiential learning capabilities is associated with the VR environment affordances in offering accommodating, entertaining and stimulating environments” (p. 280).

Experiential Learning

“Learning is the process whereby knowledge is created through the transformation of experience” (Kolb, 1984, p. 38). Learning by doing, rather learning through experience, is the basis of the Theory of Experiential Learning. David Kolb's work on the experiential learning cycle is one of the most well-known learning strategies. The cycle is divided into four stages (Figure 2): concrete experience, observations, and reflections, the formulation of abstract ideas and generalizations, and the testing of concept implication in novel contexts.

Figure 2.

Experiential Learning Cycle



The experiential learning cycle is further subdivided into two modes: attaining experience (abstract conceptualization and concrete experience) and transforming experience (active experimentation and reflective observation). As defined by Kolb (1984), transformational learning is the process of transforming experience into knowledge, and for optimal learning to occur, it is best to walk through each stage rather than entering it at any stage. In schools where virtual reality is integrated, students have the opportunity to learn through experience, by doing and interacting with technology. Chang et al. (2018) emphasized the significance of experiential education for enhancing self-concept and self-fulfillment and promoting continual learning motivation through self-concept enhancement and self-fulfillment.

As part of their study, Aiello et al. (2012) investigated how virtual reality can enhance experiential learning in a teaching-learning context. This study suggests that the virtual reality environment communicates with the world through kinesthetic interaction, in which the senses serve as mediators. While the sense and vision organs and kinesthetic structures generate knowledge, immersion in a virtual world allows one to harness this capability to facilitate long-term learning. In addition, users can interact with the environment through perceptual learning in digital reality as they do in the real world, allowing them to perceive the environment completely. In order to understand the world abstractly, an experience component is essential. According to Aiello et al. (2012), virtual reality should be considered in instructional innovations that utilize interactive worlds because it demonstrates the clarifying function of engagement in Kolb and Fry's sensory-motor model (Kolb & Fry, 1975). From this perspective of learning, virtual worlds arise from classroom activities that strengthen understanding while exploring ways to reinforce cognitive processes through sensory abilities and body behavior (Sibilio & D'Elia, 2007). Accordingly, virtual reality is beneficial for students' experiential learning since it can provide various kinesthetic engagements (Aiello et al., 2012).

According to Zheng et al. (2018), experiential education was envisioned as a means for students to practice, experience, and reflect on the meaning of life. With immersive learning, the educator's job shifts from providing knowledge to providing spaces for discovery. This might involve virtual field excursions across the world, job discovery, and high-tech training in a variety of fields. Experiential learning via immersive technology will cater to the visual, aural, tactile, and kinesthetic learner's demands. Falloon (2019) postulated that experiential education might improve general students' learning motivation and learning efficacy. It will increase their creativity, excitement, involvement, and practical knowledge.

Another research reviewed by Alhalabi (2016) attempts to investigate the use of virtual reality in assisting engineering students to learn via experience in order to improve their academic performance. According to the findings of this study, this technique allows students to experience experiences they would not have had in the real world owing to variables such as risk, excessive expense, and inconvenient times. By constructing virtual environments that emulate reality, evolve, and communicate with learners, virtual reality further integrates imagination with reality. Additionally, a virtual reality environment significantly increases pupils' success rates. In education and technology, many virtual reality apps are available that can improve student learning experiences (Alhalabi, 2016).

Summary

Discussion, Implications, and Limitations

Virtual reality offers significant value to education. However, it is still in the embryonic stage, adaptable and undeveloped. Although various other sectors have integrated virtual reality in training, the education sector is unaware of the transformative learning that occurs. Implications for virtual reality technology in education will only enhance experiential learning and generate interest in science education.

Virtual reality and its applications in education still have a great deal to learn. The research included in this review was from a wide range of training and educational environments, and while some had highly favorable outcomes, general judgments regarding the benefits of virtual reality in education were not achievable. This limitation is driven by the limited number of studies available. Research studies will become more prevalent as virtual reality galvanizes into educational institutions. Research at the nexus of learning and technology may be further bound by these limitations, as they are general for many educational types of research.

Future Research

Future research is needed to fill research gaps found in the education sector to gain a more in-depth knowledge of the functionality of virtual reality in science education as a tool for experiential learning. Although many industries have integrated the virtual realities within their organizations and seen significant benefits, educational institutions are lagging behind. Many have not yet optimized this new revolutionary way of educating students. Therefore, to gain more knowledge, the question needs to shift from should we integrate virtual reality to how we can make it work in the context we are given and optimize student learning and achievement. As researchers seek ways to placate these barriers, future research should move away from experiments outside the classroom. Researchers need to focus on educational virtual reality in an authentic setting as part of existing educational or training programs. There were no concerns discovered with the current virtual reality research due to the scarcity of it in middle school education research.

Conclusion

Technology is evolving rapidly, changing the way students learn, think, behave, understand, and interpret information. New technology integration can be a daunting task for educators, but one that is necessary to reach the new generation of learners. Studies have indicated a correlation between virtual reality integration with experiential learning and how it can transmogrify student learning. What was previously considered to be inconceivable is now part of the mainstream paradigm, with the conventional learning environment giving way to virtual settings. Virtual reality is finally transubstantiating from a niche technology to a technology that can be employed in mainstream practice. Virtual reality has made it into many industries and homes, and learners have had exposure to this technology, making the transition easier to adapt to in the educational environment.

As virtual reality technology develops, there are precise forming applications and pedagogies, but there are also considerations and challenges that are unique to the medium. Virtual reality retains a novelty factor in classrooms as it is still a relatively new concept. In order to discover solutions to such barriers, future research should go beyond and consider the use of educational virtual reality in an authentic setting as part of an educational program.

Material and Methods

Goal

This research aims to innovate instruction and infuse technology within the middle school grades through immersive technology and experiential learning. Learners are still being taught in the traditional learning methods with books, videos, and PowerPoint presentations as resources as a means for learning. This study aims to determine if learners will have a more brain-stimulating, immersive learning experience by integrating a virtual reality experience within middle school science.

Purpose

This technology integration aims for learners to have an experiential learning experience in an immersive environment. The inclusion of the virtual reality experience will replace the traditional way of learning conducted through other means of presentation. Incorporating immersive learning and virtual reality into the curriculum optimizes the learner's experiences to understand better what is being taught and transfer it to the real world.

Research Question

Proposed topics of inquiry will engage middle school girls involved in the Girls SURGE into STEM XR Summer Camp activities. Data sets have not yet been gathered. Proposed research questions which will be further explored:

RQ1: Experiential learning will increase self-efficacy.

RQ 2: Experiential learning will affect motivation to learn.

RQ 3: Will virtual reality be effective or a hindrance to learning?

RQ 4: Experiential learning through virtual reality will impact interest in science.

Hypothesis

Academic achievement will differ significantly between individuals who practice with VR simulations and those who learn with 2D simulations.

Participants

The study will take place in participants' science classrooms. Participants will be randomized to one of two groups: control or experimental. Middle school students go beyond the surface of scientific learning and delve deeper into specific areas of space science, making it ideal to incorporate Mission ISS via virtual reality. I will acquire access to these participants through a local independent school system. I want to collaborate with the school to distribute emails and flyers to parents, informing them about the research and obtaining permission for their child to participate in the research project. I will safeguard my participants by keeping them anonymous, spending their time wisely and effectively, and ensuring they are in a secure atmosphere.

Data Collection

Data collection will take several forms during the research study, including questionnaires, interviews, pretest, posttest, and distractive summative. A pretest and posttest consisting of 10 questions will be created by the researcher and given to the control and experimental groups. These questions will require the learners to evaluate how they assess technology, utilize technology on a day-to-day basis, and their thoughts about incorporating technology into their lesson plans. The control group will not have any exposure to the VR headset, and the experimental group will. A rubric will be created to rate the assessments. A post-project interview will be conducted with the experimental group learners to determine attitudes towards implementing VR headsets in the science lesson plan.

Data Analysis

Data analysis will occur using Epistemic Network Analysis (ENA) and Statistical Package for the Social Sciences (SPSS). SPSS will be used to assess significant difference between pre and post test scores. Further analysis will include descriptive statistics including mode, median, frequency, standard deviation, distribution, and paired t-test through SPSS. ENA will used to further explore the data investigating the knowledge structure of the learners at pre-and post-test. ENA models the connections between codes (i.e., items) by quantifying the co-occurrence of codes within events or episodes (e.g., pre-test/post-test), producing a weighted network of co- occurrences, along with associated visualizations for each unit of analysis in the data. The units of analysis will be defined as all of the data related with a single pre/post-test aligned within individuals. The ENA model will normalize the networks for all units of analysis before they are subjected to a dimensional reduction, which will account for the fact that different units of analysis may have different counts of coded entries in the data. For the dimensional reduction, a singular value decomposition will be utilized, producing orthogonal dimensions that maximize the variance explained by each dimension (Shaffer et al., 2016).

Instruments

Instruments used in this study will be adapted from the Instructional Materials Motivation Survey (IMMS) (Keller, 1979), Students' Attitudes to and Knowledge of Technology, Computer Attitude Questionnaire (Knezek & Christensen, 1997), and The SIC-STEM Survey 2.0, and System Usability Scale (SuS) (Bangor et al., 2009). In addition to the survey, a small focus group will be conducted at the end of the intervention to further discuss participants' attitudes towards virtual reality as a learning tool.

Projected Research Outcomes

It is predicted that the research will yield that experiential learning through the use of virtual reality impacts learning. In addition, this study expects to reveal an impact on the motivation and cognition of middle school participants.

Limitations

The sample size will be one of the most significant restrictions of this study. The availability of head-mounted displays in the form of the Oculus Quest 2 posed some limitations. In addition, a one-group, pre-test, and post-test design were used. Therefore, it is susceptible to threatening its internal validity, such as the testing effect. It is recommended that future studies aim for a true experimental design that randomizes participants into more than one group in order to compare learning design elements and approaches. Furthermore, this study was constrained because it was conducted in a laboratory setting rather than an actual academic classroom. Delimitations in this study will be determined based on the location and size of the study.

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