Virtual Reality as an Adolescent Learning Tool

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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STS Research Paper

Introduction

At age 91, Eileen Rayden stands before her childhood home. Despite being 80 years removed from the neighborhood she grew up in, Rayden can recall where she played games with friends and went sledding in the snow. Suddenly, Rayden views the Intracoastal Waterway of Florida, a site of many past fishing trips. Rayden is not traveling at lightspeed between these locations, of course. Rather, a virtual reality system allows Rayden an experience known as “reminiscence therapy” at her Santa Barbara senior living complex (Fuchs, 2022).

Virtual reality, or VR, is a novel technology consisting of simulated environments that users experience and interact with in real-time. This tool conjures old memories, soothes anxieties and ultimately provides happiness to adults of truly all ages as Rayden’s story highlights (Fuchs, 2022). VR’s proven benefits as a portal to other places are excelling in retirement homes and care facilities. Now, a growing digital ambition pushes to take the technology into uncharted territory on the other end of the age spectrum: the classroom.

Virtual reality is both an exciting and uncertain prospect as a tool for adolescent education. VR possesses the traits, contents and abilities to shape our youth in a positive way if implemented correctly. However, the road to integrating this tool in a universally positive and sustainable fashion is fraught with peril. Logistical and technical problems plague the VR introduction process. Additionally, the technology features concerning qualities of inaccessibility. Educational systems may eventually seize the benefits and reduce the drawbacks of VR environments. However, educational institutions would be mistaken to fully implement virtual reality in the near future.

The next section of this paper describes an STS framework known as the Social Construction of Technological Systems. The Social Construction of Technological Systems is a lens to observe the ever-growing wave of virtual reality integration into society. The paper then assesses existing scholarly work through a literature review. A factual analysis follows the literature review and deduces the meaning behind these existing VR investigations. Lastly, a discussion section sets findings against a greater social backdrop to assess research implications.

The Social Construction of Technological Systems

The STS framework known as the Social Construction of Technological Systems (SCOT) structures my analysis of VR systems and their adequacy for adolescent education. Scholars Trevor Pinch and Wiebe Bijker proposed this SCOT methodology to understand the relationship between technological innovations and outside social forces. The framework suggests that social interaction and human desire dictate technological development. The SCOT methodology opposes the philosophy of technological determinism and argues that isolated technological creations do not independently mold society. Rather, social desires, movements and trends determine technological development (Bijker et al., 2012). Current social attitudes regarding digital and cyber technologies match this philosophy well. Society is pushing for digital dominance everywhere. The modern world and its interconnected nature demand more electronic technologies in a building cycle; for the most part, societies and their public institutions view further cyber-development with optimism (Abelow, 2014). VR is a notable output of this digital wave. Meanwhile, the overarching digital desire directly affects the important field of education.

Individuals cannot slow waves such as this easily. Here, another STS perspective serves as a suitable underpinning to the SCOT framework. Thomas Hughes' technological momentum theory suggests technologies do not remain stagnant or function autonomously. Rather, technology has an inherent inertia to further its presence in society. Meanwhile, social forces may continually adjust the technology's features, purposes and goals. This concept emphasizes a social voice regarding the role and value of technology just as the SCOT theory suggests. The technological momentum theory emphasizes the snowball effect the digital wave will likely maintain moving forward (Bijker et al., 2012). Educators must analyze VR potential urgently in the face of this impending snowball effect.

Literature Review

Novel research accompanies the contemporary digital wave. This research is the crux of determining the efficacy of introducing VR into classroom spaces.

Proven positives to VR educational implementation are quickly apparent in literature. Linda Daniela explores a variety of educational strategies that utilize VR and notes their benefits in *New Perspectives on Virtual and Augmented Reality*. For instance, VR activities add value by pairing the body and the mind. Mental tasks combined with physical exercises strengthen adolescent students in malleable and interactive environments. These modifiable spaces additionally encourage active and participatory learning. Vast modification possibilities also allow for conceptual flexibility; previously invisible concepts, such as photosynthesis, can be represented in an immersive way (Daniela, 2020).

Alongside these strengths, Daniela highlights the "altered hybrid reality" effect of VR systems. VR stimulates the human brain with equal strength as what is induced by our senses in a real environment. Moreover, VR is shown to trigger the same neurotransmissions (the transferring of information and commands within the human brain) that generate emotion and empathy as what is experienced in real-life interactions. This baseline quality allows for the potential exploration of even more complex subjects for adolescents than what is currently being taught; the work touches on potential routes in this undeveloped space (Daniela, 2020).

Giuliana Guazzaroni and Anitha S. Pillai echo similar sentiments in *Virtual and Augmented Reality in Education, Art and Museums*. The work underlines capabilities for collaborative and cooperative learning. The authors note that, on average, students can put forth less exertion in virtual learning to gain access to the same concepts as those instructed by traditional methods. Instant feedback additionally supplements the student experience in a useful way (Guazzaroni & Pillai, 2020).

VR lesson gamification is also an effective way of grabbing student attention and selling learning in an entertaining fashion. Gamification strategies employ the structures and features of competitive gameplay to encourage student participation and engagement. Gamification practices refine a multitude of skills ranging from reaction time to the opportunity for self-assessment of strengths and weaknesses. Traditional classroom settings can certainly achieve gamification. However, VR systems offer a larger diversity of visuals, interactions and tasks that amplify the strengths of the gamification strategy (Guazzaroni & Pillai, 2020).

Lisa Jacka's *Using Virtual Worlds in Educational Settings* is the final major literature review source. This source takes a well-rounded approach to analyze the potential benefits and drawbacks of VR in an educational space. Jacka lays out core values, or "learning affordances," that a successful VR educational program should adhere to. Jacka frames some values as objectives; VR implementation should increase motivation and engagement, for instance. Other core values describe conditions that VR implementation should follow; that is, VR should only be implemented when the task at hand cannot be practically undertaken in a real setting and no other 2D alternatives can suffice.

Jacka assesses similar positives as previous sources but dives into granular limitations. Jacka notes a need for advanced graphic cards and other expensive technological additions to the classroom. The potential for student overstimulation exists within this critique of excessive technological demand. Jacka additionally points out that VR users lack natural body language for teachers to detect as crucial feedback. Ultimately, Jacka assesses a necessity for future research in the educational VR field. This research may expand upon existing benefits and reduce current pitfalls to ensure VR does not join a long line of quickly disposed technological fads (Jacka, 2018).

Myriad other scholars provide adjacent support to these main sources. Theodosia Prodromou's *Augmented Reality in Educational Settings* explores augmented reality (AR), a tool essentially adjacent to virtual reality. AR overlays virtual content on the immediate surroundings of a user rather than providing complete VR immersion. AR qualities will not be explored in this research paper. However, Prodromou's initial arguments apply- a particular highlight is the ability for VR/AR systems to provide fundamental training in digital competence for our youth. Teachers can instruct adolescents on basic technological skills in a risk-free environment using current VR systems. This possibility will translate to later technological capabilities and successes in a society dominated by digital spaces (Prodromou, 2019). Similarly, *Integrating Technology in the Classroom* provides broad-level support for technological integration in the classroom. The work outlines the foundations of technological capability that should be instilled in young students and structures a guide towards achieving this inculcation (Hamilton, 2018).

Literature research concluded on sources that were fine-tuned to small details within the VR-education relationship. Evidence provided by these sources is best presented within the context of the analysis section. This suggestion is particularly true for sources that present criticisms and major problems that VR contains as an educational tool. The upcoming analysis weighs the positives outlined by the primary literature review sources against potential obstacles to sustainable VR implementation.

Analysis of Possibilities for Virtual Reality in Education

Proven Positives of Virtual Reality

The literature review demonstrates that virtual reality possesses a number of diverse positive qualities. Immediately, the ability to strengthen student engagement is a powerful tool for educators; this is especially true for adolescents, a population typically not known for its attention span. VR's ability to replicate natural brain activity is exceptionally promising for its long-term health. The technology is worthy of trust if it consistently reproduces the brain reactions and transmissions that real-life experiences yield (Daniela, 2020). The experience does not appear to be a cheap, gimmicky or disposable rush. Instead, VR offers a true reproduction of everyday sensory experiences, decisions and learning actions. In addition, most students of the new digital era are familiar with operating electronic technology and its many moving parts. At a minimum, students are typically capable of getting up to speed with electronic tools and their components rather quickly. Thus, VR does not require a steep learning curve to reach an adequate level of experiential replication (Juraschek et al., 2018).

Teachers crucially join students in the VR fun. VR lessons often make teachers active participants in current exercises and games rather than mere facilitators. Jacka terms this idea as educator presence. Effective educator presence reduces student isolation and coalesces teacher and student into a cooperative team (Jacka, 2018). Adolescents join forces with their teachers in an extremely democratic and open setting. This helps students feel less like a "subject" forced to digest lessons, lectures and other traditional learning techniques (Badley & Patrick, 2022). Both parties can truly participate equally and effectively. This format encourages students that their teacher is present to help with and join in on their education rather than present to simply execute lessons.

Gamification strategies in VR are additionally beneficial. Gamification offers students instant feedback and instant gratification for any progress made that will feed continued usage (Guazzaroni & Pillai, 2020). Instant feedback is an exceptional tool that benefits both teachers and students. Students can quickly understand their faults, while educators can fine-tune learning paths and goals to the needs of an individual student (Jacka, 2018). The user (the student) is always in control, able to sculpt their environment personally or play in a game to the best of their abilities. Teachers can easily adjust the road ahead for students when an insurmountable hurdle is reached; game difficulties can be adjusted and helpful hints may be employed. These supports are instated individually within specific VR systems; entire classes will not need to slow down to ensure everyone keeps moving forward. Individual student control also encourages positive self-determination and experimentation. Adolescents can firmly take hold of their experience with autonomy.

Case-by-case learning modification also allows students with Special Educational Needs (SEN) to be included within a VR integration program. For instance, VR grants autistic individuals the opportunity to navigate "day-to-day situations" such as visiting a grocery store or catching a bus. SEN individuals receive risk-free and controllable practice with scenarios that are often overstimulating in real life. These practices build user confidence, comfort and independence in everyday settings. SEN individuals may also improve social skills through cooperative VR environments (Anderson, 2019). The nuances of the relationship between SEN students and VR are ultimately worthy of a separate exploration; for now, proven VR benefits are encouraging to the discussion at hand.

Virtual Reality Exclusions and Inaccessible Qualities

VR is inherently inaccessible in a few key fashions despite its proven benefits. Financial inaccessibility is the most apparent format. The youth of VR as a viable technology means it is a tool that comes with great expense. Prices for a single VR headset for a classroom can range anywhere from $300 to $600 (Levesque, 2016). Naturally, a single headset for a whole class would not be sufficient if VR advantages are to be harnessed in any meaningful way; a lone shared headset would eliminate many of the advertised system benefits such as live collaboration and interaction. Thus, the sticker price above must be scaled to cover potentially hundreds of students. Furthermore, while the price tag includes the variety of accessories needed to properly operate the headset such as handheld controllers and charging stations, it does not factor in potential long-term maintenance costs. These costs will reach exorbitant levels when scaled up to supply entire school systems. Private, charter and wealthy public school systems may be able to properly afford and maintain the technology. Meanwhile, less affluent school systems with limited disposable revenue are effectively priced out of incorporating virtual reality in a complete and sustainable manner. VR implementation could excessively stratify the strength of educational experiences that school systems can provide on economic lines.

In addition, VR mandates a considerable amount of physical space. Students require an adequately sized radius of free area to operate the system without clashing with classroom objects or even other students. Many school buildings are not built to handle such large spatial needs. Storage is another critical spatial constraint. Large and awkwardly shaped headsets are difficult to stow away in a compact manner, particularly when schools hope to simultaneously dock them to charging ports. School systems will vary widely in their ability to carve out a footprint for these devices when they are not in use. The ability or disability to physically add VR to school grounds could widen the gap between school systems in a problematic way, just as was the case with cost.

Physical exclusions are also present in most contemporary virtual reality technologies. Most modern virtual reality systems consist of a headset positioned close to the face along with two hand-held controllers used for navigation. This larger design pattern rarely varies in size or composition. Such ubiquity in design renders VR nearly unusable for many individuals with specific disabilities. Handheld controllers are an insurmountable hurdle for those who lack precise motor skills in their arms and hands. Furthermore, individuals who possess a prosthetic extremity will struggle with refined operation. New VR extensions such as WalkinVR Driver have sought to rectify this crucial issue. However, these plug-ins are still in early development and not universally sustainable. Plug-ins also add to the price tags prescribed above by serving as an adjacent product to the base VR system ("How Virtual Reality Can Be More Accessible," 2022).

VR designs also feature headwear issues. The technology currently appears eliminated as a possibility altogether for blind individuals. Meanwhile, users with less severe visual impairments experience difficulty mapping their vision to a proximal screen and clearly processing it as a new landscape. Environmental interfaces, directions and menus that require reading have particularly become large barriers to easy use. Extensions and workarounds have also been considered here by start-up developers and scholars. However, many of these extensions have also idled in infant research stages or have been abandoned altogether ("How

Can a Blind Person," 2022). Sight is built into VR functionality and success; any deviations from perfect vision have a realistic chance of being left out of the picture.

VR possesses additional active-use drawbacks. These drawbacks mostly deal with usage over a long and sustained period of time. Eye strain is noted as a consistent takeaway from sampled students and mandates frequent breaks and checkpoints. These frequent breaks interrupt immersion and prevent educators from executing an entire school day within VR. Additionally, researchers located long-term detachment from reality as a potential negative; students admitted to feeling fatigued and disconnected after a significant VR usage period. This weakness further makes a full VR school day untenable (Guazzaroni & Pillai, 2020).

Integrating Virtual Reality into the School System

VR would not be the first novel technology to enter the classroom in a procedural rollout. Interactive whiteboards (or IWB) were a voluntary educational addition attempting to strengthen class engagement. IWB integration was an early tide of the same digital wave that now pushes for the introduction of VR. IWB novelty radically changed classroom culture: instruction once built on lectures and worksheets now transitioned to harnessing a central collaborative and hands-on tool (Firmin & Genesi, 2013).

Radical changes such as this take adaptation. Educator knowledge when it comes to properly using such a novel technology varies widely based on their past experiences and attitudes toward digital technologies (Lasić-Lazić et al., 2018). Interactive technologies are omnipresent for our youth, making IWB introduction feel like a natural and logical step. Teachers, meanwhile, must grapple with educating a child in a "digital era" that they did not experience themselves while growing up (Forkosh Baruch & Erstad, 2018). Additionally, as intuitive as a digital whiteboard may seem, many drawbacks were noted in its introduction, ranging from constant board reorientation to long boot-up times (Firmin & Genesi, 2013).

VR shares several qualities with IWB. Both tools focus on strengthening class involvement and attention. Additionally, both tools seek to streamline peer-to-peer collaboration. Each technology frequently provides the chance for students to exhibit creativity and exploration in their learning. These shared characteristics make it rational for educators to expect that VR will require the same challenging adaptation period as preceding IWB introductions. It is also likely that VR implementation will usher in similarly unforeseen technical problems in early rollout stages that will not have been predicted in initial trials.

Teachers will also need to determine which subjects are suitable for VR usage and which are not. Researchers have attained exemplary studies in disciplines as different as drama and science. Importantly, these studies demonstrate that student attitudes and responses toward new VR usage are overwhelmingly positive (Southgate, 2020). However, this proof is most applicable to subject-specific lessons commonly featured in higher levels of education. The lines between subjects are far more blurred (or, in some cases, combined) in adolescent education. The odd middle ground of adolescent education thus places uncertainty on the table. Teachers must refine VR pedagogy to fit often unique childhood lessons; life values and social skills, for example, are typical additional objectives of adolescent education not required in higher learning spheres.

Existing metrics for student success likely also fail to perfectly apply to this new technology. Traditional success metrics involve standardized testing. Standardized testing is a counterintuitive measure for evaluating student success in a tool that is designed for non-standard experimentation. A common metric simply cannot monitor or examine VR freedom; a uniform examination strategy would fail to capture the diversity of VR experiences available to students and would negate the afforded concept of exploration and discovery. A new system of metrics will be needed beyond current formats of student progress assessment; for now, the form this will take is uncertain.

Conclusions and Looking Forward

Virtual reality efficacy is ultimately divided. The positive traits VR can offer are clear, but many obstacles lie in the way of a smooth and sustainable integration process. These challenges are not a bridge to be crossed when we get there. Rather, solutions must be prepared well before the problem is actually encountered. An improvisational approach to introducing this newfound educational tool risks getting set in very flawed and ill-considered ways. Society has witnessed these educational improvisation failures before. For instance, the Covid-19 pandemic mandated an immediate change to underdeveloped online learning methods. Scholars had long acknowledged the difficulty in getting online education methods to reproduce the spontaneity and informality that best suit adolescent education (Ricevuto et al., 2022). Educational systems never addressed this problem in the hopes that ubiquitous online learning would never be needed; unfortunately, this feared issue soon mired pandemic education in learning retention difficulties and even learning loss (United States Government Accountability Office, 2022). The tool was introduced out of necessity in an unprecedented period. Nonetheless, pandemic educational experiences should serve as a cautionary tale regarding improper tool preparation and subsequent sub-par learning.

Public education effectiveness is a hotly-debated topic. Institutional support and funding frequently wax and wane in political conversation. It is critical that large changes such as VR integration are carefully considered and reliably projected as successes. Improper implementation risks damaging or stratifying educational spheres. This risk is too great to rush into an unpredictable program (Hochschild & Scovronick, 2003). Thankfully, virtual reality has yet to be implemented into American education in any meaningful way. The technology is infrequently utilized beyond basic testing or usage as what is practically a novelty tool. However, as is observed in previous technological installations in the classroom, full-scale implementation often simply requires a lone administrative greenlight (Firmin & Genesi, 2013). A few key individuals could promptly instate the technology wherever they deem fit, and while rollout would be a long process, the choice would be finalized. Thus, educators must continue to urgently analyze VR added value before those in power reach an official decision.

This urgency speaks to the force of our greater digital wave. Ideally, the wave of digital innovation should contain more hesitation and careful planning. Virtual reality is well established in the public mind as a cutting-edge and promising new technology; however, it is ridden with problems that would prevent a seamless introduction into our most essential institutions. One can only imagine what more experimental and untested technological fads may bring if a technology as well-projected as VR has this many issues. If society sets a precedent of granting full-scale introduction to whatever the shiniest new technological toy is, we risk far more dangerous implementations in the future.

Regardless, proven VR benefits should be utilized whenever and wherever they can be instated responsibly, securely and equally. Virtual reality trials and workshops should additionally persist in school systems. These trials may continue to uncover new mechanisms and methods by which VR can be harnessed to an advantageous extent. We should continue to experiment and refine our strategies to make VR a universally helpful tool not bogged down by inaccessibility or barriers. Nevertheless, the technology's youth as a product is concerning. Various outside structural problems currently eliminate the possibility of a perfect path for VR educational introduction. With time, we may be able to seize VR benefits and introduce our youth to technological innovation and new possibilities; for now, the technology is simply not ready.

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