Virtual and Augmented Reality Technologies in the Organization of Modern Library Media Space

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Summary
Virtual and augmented reality technologies provide access to learning materials and improve the organization of a modern library's media space. This article aims to identify the significance and role of virtual and augmented reality technologies in the modern library's media space organization. Methodology. The research uses a university library case study methodology to empirically investigate virtual and augmented reality technologies. Results. Virtual and augmented reality technologies provide research and improve learning outcomes by engaging students and learners with significant interest in such technologies. Libraries offer users the opportunity to create their VR content through available software. Students can test their VR content in the libraries' labs. Libraries support access to a variety of virtual and augmented reality content. The content is accessed using "virtual reality headsets" for viewing and workstations with "authoring software and loanable 360 cameras" for creating. The library lab is a space to support students' digital creativity and research through virtual and augmented reality. There are 3D Design Labs within the libraries as a medium to large group design learning spaces with virtual reality technology. Libraries form a media space where users can create videos, podcasts, portfolios, edit media, and book tours, and students and researchers can explore different scientific knowledge. In this way, technology ensures that risks in learning are minimized as opposed to hands-on seminars and classes.

Keywords:
virtual reality, augmented reality, library media space, libraries technologies.

1. Introduction

Libraries face some challenges related to budgetary limitations and funding shortages, growing concerns about data privacy, digitization of materials, and accessibility of library materials regardless of where users are located. In response to these challenges, new technologies are emerging, including virtual and augmented reality. They offer new opportunities for providing new services and organizing media space more efficiently. Technology is expanding how library materials are provided and received and how users can interact with them (Varnum, 2019). Therefore, libraries and archives are increasingly using AR/VR technology to provide services, a pervasive trend (Oyelude, 2018).

This article aims to define the meaning and role of virtual and augmented reality technologies in the organization of the modern library's media space.

2. Literature review

Virtual reality (VR, artificial reality) is a technology-created world that is experienced by a person through senses: vision, hearing, touch, and others (Varnum, 2019). Virtual reality mimics both action and reactions to that action. The computer synthesis of virtual reality properties and reactions is conducted in real-time to create a convincing set of reality sensations. Virtual reality should not be confused with augmented reality. Their principal difference is that virtual reality constructs a new artificial world, while augmented reality only introduces individual artificial elements into the perception of the real world. Augmented reality is the term for all projects aimed at supplementing reality with any virtual elements. Virtual reality systems are devices that more fully simulate the interaction with the virtual environment by influencing all five human senses compared to conventional computer systems. Augmented reality (AR) can be understood as a virtual reality (VR) form.

Virtual reality (VR) is a rich visualization and analytical platform that contributes to the library's mission of providing access to all forms of information and supporting pedagogy and science across disciplines. Academic libraries are increasingly using virtual reality technology for research and instructional purposes variety. It includes providing enhanced access to digital collections, offering new research tools, and creating new immersive environments for students (Cook et al., 2019). As described by Indiana University, Bloomington's Blogspot, VR "includes the use of 3D graphics and advanced interaction tools to immerse the real user in a simulated environment." AR stands for augmented reality and technically means a combination of virtual and real-life environments.
The literature analyzes the current challenges and benefits of using VR/AR in libraries using examples from specific

Manuscript received May 5, 2022
Manuscript revised May 20, 2022
https://doi.org/10.22937/IJCSNS.2022.22.5.53

institutions (Oyelude, 2018). Pellerin, Mi & Valk (2019) explore the potential of using augmented reality (AR) and virtual reality (VR) technologies with archival materials to enhance STEM-based learning and outreach in the university. AR, VR, and archival resources support pedagogical models, including constructivist learning, inquiry-based learning, and game-based learning. The authors explore the democratization of libraries and archives with simulated environments via analysis of current technology requirements design and learning institutions using AR/VR in conjunction with special collections.

The literature notes the advantages and disadvantages of AR and VR technologies. VR does not involve actual artifacts or environments, making it possible to develop projects outside of the media space if there are no technical issues with the hardware. The downside is that today's high-end VR technologies and devices require specific configurations (Pellerin, Mi & Valk, 2019). The major VR devices are the Oculus Rift, HTC VIVE, and HTC VIVE Pro, which require powerful computer hardware for high-quality graphical display. The technologies are also tied to heavy headsets and electrical sensors as part of the device kit. There are portable mobile virtual reality devices (Google Daydream VR, Google Cardboard, and Samsung Gear VR) that give users the ability to use VR on their phones as long as graphics quality and room scaling are not core design elements. Different variations of VR devices open up possibilities for archival designs.

The AR design, unlike VR, uses a local environment and interacts with it for its functioning. Therefore, some AR designs related to the digitization of the archives can only be implemented close to the archival materials or within an environment with embedded information about the materials (e.g., QR codes). AR enhances the user experience through interaction with the physical environment. The AR advantage for archival projects is the ease of access to the equipment, in most cases requiring only a smartphone. It also has the advantage of being able to design only certain information, including text, image, audio, video, 3D scanning, and virtual prototypes. These advantages and disadvantages of technology should be considered in the project's design, which aims to create a digitalization of archival materials.

The potential of using AR and VR technologies to educate and provide access to archival materials is enormous but requires collaboration with partners outside the industry. For example, Sutherland (2016) suggests that "collaboration with scholars in areas such as digital humanitarian sciences and the use of new media technologies... it creates new opportunities for archivists to capture and preserve findings and other traditions, practices, and events." (p. 393).

Various projects with AR and VR are implemented in archive-like environments, primarily in museums and cultural heritage sites with educational purposes. Such projects allow the pedagogical theories' use, such as constructivism and inquiry-based learning. Vong (2017) notes that "special collections and archives have great potential to nurture students' curiosity. Therefore, using a learning framework in this environment can transform it from just a physical space where books, papers, and objects are stored to a place filled with discussion and interaction between students and teachers" (p. 150).

VR and AR technologies provide enhancements to archival learning pedagogy by creating a relationship between documents and artifacts to each other to display contemporary information styles retrieval and presentation. The development of VR environments and AR tools to help explore archival materials encourages students to reconsider the relevance of past events to current issues. Rockenbach (2011) writes that "...students should be exposed to learning spaces in which they 'deal with topics that stimulate and open intellectual horizons and provide opportunities for learning through exploration in a collaborative environment'" (p. 299).

The multidisciplinary nature of VR and AR projects using archival materials requires creating an environment where people of different skill set work toward an end goal. Teachers are also key stakeholders in this scenario. Virtual reality and augmented reality systems that use archival materials have a variety of lesson plans and curricula that can increase the archives' usability to a diverse audience.

3. Methodology

This article uses the case study methodology of university libraries to empirically investigate the work of virtual and augmented reality technologies. The case studies are based on the following libraries: 1) Lauinger Library of Georgetown University (https://library.georgetown.edu/vr), 2) The VR Lab in Waldo Library of Western Michigan University (https://wmich.edu/library/vr), 3) Illinois Library of University of Illinois (https://www.library.illinois.edu/leitc/virtual-reality/), 4) ORU Library of Oral Roberts University (https://oru.libguides.com/avr), 5) Libraries of Hudson County Community College (https://library.hccc.edu/technology/VR).

4. Results

Virtual Reality technologies in Lauinger Library have endless uses in educating and training students by integrating the game method and practice in a virtual environment. Students can practice dangerous military maneuvers and simulate complex operations using a headset and entering virtual reality. It allows users to conduct research that might otherwise be dangerous or

impossible. According to Lauinger Library's description, “VR has infinite uses in entertainment, education, medicine, military, and more. People can play immersive video games, practice dangerous military maneuvers, and simulate extremely complex surgeries by simply putting on a headset and entering a virtual reality. Immersive technologies change or expand the physical world by merging it with digital or simulated reality, creating a new world for immersion experiences. For example, Augmented Reality (AR) creates a digital addition, or layer, to your reality and Virtual Reality (VR) is a full immersion into another world or reality, shutting out the physical world (Virtual Reality in Lauinger Library).

The Waldo Library of Western Michigan University website provides a list of tools for creating VR content, namely 3D modeling, VR game engines, content creation tools (Adobe Creative Cloud including: Photoshop, After Effects, Premiere, Audition, Fuse, Character Animator, Illustrator). Western Michigan University Library offers users a VR Lab (The VR Lab in Waldo Library) where everyone can create their virtual reality to conduct research and improve learning outcomes. These technologies power The VR Lab in Waldo Library. Users are offered two ways to use VR technology in the lab:

1) Oculus Quest, a three-unit virtual reality headset, no computer, no wires - a comprehensive gaming system that allows users to play virtual reality with only the headset and handheld controllers;

2) Oculus Rift (7 units available) - VR workstations equipped with Alienware computers with Intel i7-7700 (3.60 GHz) processors, 16 GB of RAM, and NVIDIA GeForce GTX 1080 graphics cards.

These VR technologies in the Waldo Library indicate the potential for their use for educational purposes. In addition, software and other learning tools are available for users to create their own VR content. Students can also test their own VR content in the Waldo Library lab.

The Illinois Library supports access to many virtual and augmented reality content ("...of 360 virtual and augmented reality content") for viewing content during class and creating content. For watching, they use "virtual reality headsets," and for creation, they use workstations with "authoring software and loanable 360 cameras. Many library technologies are available for the reserve to students and researchers by appointment.

The Grainger Engineering Library IDEA Lab Virtual Reality Lounge includes a workspace for student groups with virtual and augmented reality technologies, including:

1. HTC Vive Pro w/Wireless Kit.
2. Oculus Go, Oculus Quest.
3. Oculus Rift (loanable kits available for check out at Grainger Circulation Desk).
4. Valve Index.
5. Microsoft HoloLens.
6. VR workstations with software, including Unity, Unreal, Oculus Rift, Mixed Reality Portal, Steam.

The lab is a space to support students' digital creativity and exploration using virtual and augmented reality technologies. The lab operates the Immersive Learning Lab, a place where students can set up a virtual reality club using the technologies offered (Valve Index, HTC Vive Pro, Oculus Rift S, Oculus Quest & Quest 2, HoloLens 1 & 2) and software (Figure 1). «The capacity of the ILL is 8. There are two 84” wall-mounted displays, and 8 individual workstations with high-end AlienWare».

Fig. 1. Immersive Learning Lab.Source: https://www.library.illinois.edu/enx/idealab/spaces/

The Grainger Engineering Library IDEA Lab also includes a 3D Design Lab, a design learning space for medium to large groups with virtual reality technology (Valve Index headsets, HTC Vive Pro, Oculus Rift S, Oculus Quest & Quest 2, HoloLens 1 and 2) and computers with software such as Adobe (Illustrator, Photoshop, Premier Pro) and Audacity that allows students to learn and perform creative activities (Figure 2).

Fig. 2. 3D Design Lab.
Source: https://www.library.illinois.edu/enx/idealab/spaces/

Thus, the Illinois library forms a media space where users can create videos, podcasts, portfolios, edit media, and book tours (https://www.library.illinois.edu/mc/). The library's media space offers students and researchers virtual reality headsets, 360 cameras, and authoring virtual reality software for 360 video editing.

The ORU library of Oral Roberts University also offers students virtual reality headsets (VR headsets: HTC Vive, Oculus Rift S, and Oculus Quest) that provide a fully immersive virtual space experience, allowing the user to interact with objects created by computers.

The Libraries of Hudson County Community College provide access to a variety of virtual and augmented reality content for students to view (via VR headsets), such as the HTC Vive and Oculus Go. The library offers technology to simulate vision and opportunities to interact with different walks of life in different periods and fields of study. Library engineers are constantly improving technology to provide more interactivity and realism. VR technology is advancing rapidly and is a new way to learn. Students can teleport back in time and see life in the past tense. Students and researchers have the opportunity to study various scientific knowledge (the structure of the human cell and, in general, the human anatomy; take virtual journeys, see the White House, national parks, and old ruins on other continents; explore the surface of planets; etc. In this way, technology ensures that risks in learning are minimized as opposed to hands-on seminars and classes.

5. Discussion

Altogether, VR and AR are central to the technology being used in libraries and museums in 2018. The research continues, and VR and AR are being used more. It is safe to assume that much more will be said about virtual reality and AR in other related fields, such as archives and documentation centers and everyday use, through "non-creative" ways of using them (Oyelude, 2018).

According to Oyelude's (2018) research at the Geisel Library, the University of California, San Diego Digital Media Lab (DML) uses student and faculty experiences to provide interactive learning. The library offers free 3D printing, the use of VR headsets, and expert advice. Virtual reality technology provides many benefits: The library's 3D printing helped return a turtle to shape by replacing its hind shell; 3D scanning of a Roman coin collection revealed small details and also produced prototypes of expensive equipment, greatly reducing its cost. Academia and conferences have discussed the benefits of virtual and augmented reality technologies. For example, Dar (2018) posted on the School Library Journal blog about three steps for introducing virtual reality to teens at the American Library Association (ALA) winter conference, seeing VR as a way for librarians to create educational programs that resonate with teens' interests. Dar (2018) notes the benefits of the VR Oculus Rift headset used by library students. To increase interest in technology, it is recommended for libraries to get teens interested in a virtual reality device by asking them to help understand how to use it; create themed curated programs related to events that teens identify with, such as Black History Moon, Independence Day, etc., and use statistics to identify the focus; and encourage teens to add their content. Library staff should encourage students to make short films with the provided cameras that they can view through Oculus Rift.

The Google Tilt Brush, which allows users to draw in 3D, is another device that helps create VR or AR. According to Oyelude (2018), students at the University of Iowa developed Gravbox, a real-world sandbox to help imagine how gravity works. To use Gravbox, they first sculpt an environment out of the sand, then a computer program projects a moving particle onto the terrain. The designed particle simulates how an object (such as a comet or space explorer) would travel across an imaginary landscape. The sandbox, developed through teamwork by a group of students and faculty, is a VR learning tool. Libraries can provide spaces and services where they can create and use the above simulated virtual objects that replace reality and help learn scientific disciplines.

Pellerin, Mi & Valk (2019) proved the importance of virtual and augmented reality technologies as a way and tools to improve pedagogy and student engagement methods in the Georgia Tech Library. Students in the Computational Media program at Georgia Tech

specializing in interactive game design, human-computer interaction, digital art, media theory, media history, and software design. In their research, students implement technological problem solving by developing prototypes of potential solutions. For such development, students make extensive use of AR and VR technologies with archival resources that allow them to work with large amounts of archival material stored in a repository outside of libraries. In this way, AR and VR technologies contribute to a state-of-the-art, high-capacity space with ideal climate conditions, providing access to most collections of instructional materials on demand. Georgia Tech librarians and archivists are mentors for students participating in these research sections. For example, in fall 2017 and spring 2018, students worked with the Georgia Tech Library Instructional Program and the Data Visualization Lab on using virtual reality for teaching and learning in one of the special topics' courses. The main program goal is for students to identify key components of the VR design and development lifecycle through hands-on experience. In addition, as part of the program, students prepared a report cataloging campus resources and tools needed for these types of projects. The student group also analyzed the use of virtual reality technology to demonstrate, enhance, and engage other students in the library's special collections. Students were encouraged to use immersive technology to address the accessibility of unique resources using storytelling and an experiential learning approach, the student team first developed virtual storytelling as part of a learning game that would introduce other students to items in Georgia Tech's archival collection. In this way, VR technology allows students to experience library resources in a virtual setting and provides interaction and interactive learning. To digitize library resources, students had them 3D scanned. The Artec Spider 3D scanner was the primary tool used to capture 3D images of artifacts from Georgia Tech's special collections. The scanning process created a three-dimensional representation of the object that could be imported into Unity, the cross-platform game engine, a class used to develop 3D content and compile all the content into a VR game. However, given several problems with scanning artifacts, the students redesigned the project by scanning only photographs. Thus, an interactive campus tour was created that included scanned photos of campus landmarks and some historical images from the library archives.

The analysis by Pellerin, Mi & Valk (2019) indicates that the potential for the use of virtual and augmented reality technologies is extremely large. At the same time, some issues inhibit their use (e.g., artifacts' digitization by students). That said, technology is an effective tool for engaging students, students in libraries by enabling students to create virtual content.

The growing popularity of virtual and augmented reality (VR and AR) technologies (Pope, 2018b) and increased research on their use in education have led to their appearance in many academic libraries. However, few studies address the actual use of such technologies by libraries and the structuring of library services around them (Greene & Groenendyk, 2020). Despite the increasing popularity of technology, a study of virtual or augmented reality technology adoption programs by academic libraries by Pope (2018a) found that 44% of libraries had some form of virtual or augmented reality available. Of the remaining respondents, 34% said they were in the initial stages of creating the program or were interested in launching it in the future. Many interviewed library staff and educators also indicated a lack of intention in developing the program, citing many reasons. Among them, the most common was a lack of interest in the library itself or opposition from colleagues. At the same time, student and user interest in virtual reality were identified. However, a lack of technology purchase in the library was the reason that prevented planning for the media space from the beginning. Also noted was a lack of need for such technology due to visitors gaining access to VAR equipment through an information technology initiative on-campus or local government. The budget was also a limiting factor in the adoption of technology. While there is considerable interest in virtual reality, it is often not used due to a lack of support within the library or governing body itself. The most popular devices used in libraries are the HTC VIVE, Oculus Rift, and Google Cardboard.

Greene & Groenendyk (2020) also researched the websites of Association of Research Libraries (ARL) member libraries to gather information about the availability of VR and AR equipment and to provide access to such technology. Along similar lines to this study, the authors also found that a significant number of ARL member libraries do offer access to VR technology, while AR technology is much less common. The most common technologies offered were the Oculus Rift and HTC Vive, which were offered quite often only for library use by appointment.

Hannah, Huber & Matei (2019) discuss possible pedagogical applications of virtual and augmented reality (VR and AR) within the humanities/social science curriculum. The authors note the critical need for academic libraries to collect and manage 3D objects using such technologies. At the same time, the very creation of infrastructure and media space is critical to ensure the innovativeness of libraries and the learning/research activities of students.

6. Conclusions

Virtual and augmented reality technologies provide scientific research and improve learning outcomes by engaging students and pupils who have a significant interest in such technologies. Libraries offer users the opportunity

to create their VR content through available software. Students can test their VR content in the libraries' labs. Libraries support access to a variety of virtual and augmented reality content. The content is viewed using "virtual reality headsets" and created using workstations with "authoring software and loanable 360 cameras." The library lab is a space to support students' digital creativity and research through virtual and augmented reality. The 3D Design Lab functions within the libraries as a design learning space for medium to large groups with virtual reality technology. Libraries form a media space where users can create videos, podcasts, portfolios, edit media, and book tours, and students and researchers can explore different scientific knowledge. In this way, technology ensures that risks in learning are minimized as opposed to hands-on seminars and classes.

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