An Exploratory Study on Virtual Reality and Related Technologies in Terminal LIS Degree Programs in the United States and South Korea

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ABSTRACT

With growing public, educational, corporate, and governmental interests in the "Metaverse" and 4th Industrial Revolution, virtual, augmented, mixed, or extended reality technologies have seen renewed interest and expanded adoption across contexts. While libraries and librarians have long provided their communities access to information, media, and technology, and are not strangers to virtual worlds, there is little work on whether LIS programs are preparing pre-service librarians to be knowledgeable of VR and related technologies and their applications in libraries and other information organizations. As such, this study employs a selected literature review on how libraries provide and use virtual reality and related technologies in their collections, programs, and services as well as a summative content analysis exploring the inclusion and use of virtual reality and related technologies in the curricula of terminal LIS degree programs in the United States and South Korea. The literature review identified three key, interconnected themes: stakeholder partnerships, content development, and inclusion and accessibility. Findings from the summative content analysis suggest that the level of inclusion of VR and related technologies in terminal LIS programs is low in both the United States and South Korea. Of the few existing courses covering XR technologies, it appears that most cover content development, while fewer address issues related to stakeholder partnerships, and inclusion and accessibility. Recommendations for LIS educators interested in developing courses or training about VR and related technologies in libraries are discussed.

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1. Introduction

With recent advancements in technology as well as investment from major media and technology companies, educational institutions, and governments, there are renewed and expanded interests in the metaverse and virtual reality technologies. Facebook's recent rebranding to Meta is, in part, about its shift to focus more on the metaverse and the development of its Horizon Worlds VR platform (Griffin, 2021). Meta's (formerly Oculus) virtual reality head-mounted display (HMD), the Quest 2, sold over ten million units since it launched in October of 2020 (Gartenberg, 2021). In October of 2021, Mayor Oh Se-hoon announced that the city of Seoul plans to expand into the Metaverse to offer municipal and public services (Lee, 2021). South Korea's Science and ICT minister, Lim Hye-sook, introduced the government's plans to become the fifth largest metaverse market by 2026 through strategic investment in local metaverse companies (Yonhap News Agency, 2022). Pukyong National University in Busan, South Korea, announced their own metaverse platform to facilitate online learning and campus events starting with its Spring 2022 semester (Pukyong National University, 2022). The potential of the metaverse clearly has appeal across various industry and public sectors, so what is it?

While the term "metaverse" has attracted much attention recently, the concept is not new. In fact, the metaverse was first coined and described in Neal Stephenson's science fiction novel, Snow Crash, in 1992. Ball (2021, para. 30, bold in original) defines the metaverse as "a massively scaled and interoperable network of real-time rendered 3D virtual worlds which can be experienced synchronou sly and persistently by an effectively unlimited number of users with an individual sense of presence, and with continuity of data, such as identity, history, entitlements, objects, communications, and payments." Ball (2021) notes that the metaverse is often conflated with virtual reality or video games, and explains that virtual, augmented, mixed, and extended reality technologies are means through which users can connect to and experience the metaverse or games. Virtual reality (VR) enables users to view and interact with a synthetic or simulated environment from the first-person perspective, typically using VR headsets or Head Mounted Displays (HMDs) (Kim, 2020). Augmented reality (AR) technology layers digital or virtual objects over the user's view of the real world, often using smartphones or smart glasses (Kim, 2020). Mixed reality (MR) is a combination of virtual and augmented reality technologies that combines the real and virtual worlds into a connected experience; MR can also be accomplished with smartphones, AR wearable devices, and some VR headsets (Kim, 2020). Extended reality (XR or xR) is a category of technology that changes or replaces a user's view of the world and, as such, XR encompasses VR, AR, and MR (Kim, 2020).

VR and related technologies have current and potential applications and uses in a wide variety of contexts and industry sectors, from entertainment, business, and education to medicine, business, research, and development. Kim (2020) identifies virtual reality as one key technology for libraries to be ready for in the 21st century. Smith (2019) argues that virtual reality in libraries is an easy decision, that it can be used for a variety of services and educational programs, such as for teaching information literacy skills. Greene and Groenendyk (2018) argue that VR and AR technologies not only allow library users to engage with new types of media, but to engage with traditional media in new ways. They argue these aspects of VR and related technologies are reason enough

for libraries to consider adopting them, with the risk of falling behind if they do not.

Librarians and libraries are no strangers in virtual worlds, having created, curated, and provided digital collections, programs, and reference services in virtual worlds like Second Life[1] for two decades (Chow et al, 2012; Dey, 2012; Grassian & Trueman, 2007; Hill et al., 2017; Mon, 2012; Parry, 2008; Webber & Nahl, 2011). Some of these virtual libraries are still open and active. For example, the Community Virtual Library[2] offers collections of e-books and other electronic resources, exhibits, events, and reference services in Second Life and OpenSim[3] with plans to expand into other virtual worlds. Reporters Without Borders created The Uncensored Library[4] in Minecraft[5] to allow citizens from around the world to access journalism that has been censored in their home countries (Maher, 2020). Of course, a core value or mission of librarians and libraries is providing access and use of information, media, and technology to their communities. As the metaverse gains interest and VR, AR, MR, XR and related technologies gain adoption and accessibility, libraries and librarians may leverage their experience with technology and virtual worlds to engage and support their communities as they explore new virtual worlds. As seen below, many libraries, as media hubs and makerspaces, are already supplying access and supporting VR and other technologies and are well on their way in preparing for the metaverse.

However, there does not appear to be prior work exploring the inclusion of VR, AR, MR, or XR in Library and Information Science (LIS) curricula. As such, this study includes a selected literature review of the uses of VR, AR, MR, or XR technologies in various types of libraries as well as a summative content analysis and brief comparison of terminal LIS degree programs in the United States and South Korea. The backgrounds and research interests of the authors provides a unique opportunity to explore the commonalities and differences between LIS programs in the US and South Korea. Insights from the selected literature review and summative content analysis will be used to highlight key recommendations for LIS educators interested in teaching about or using VR, AR, MR, or XR technologies in their libraries or classrooms to better prepare pre-service librarians and, by extension, their communities to be better prepared for the Metaverse and 4th Industrial Revolution.

2. Selected Literature Review

Due to scope and space limitations, this selected literature review provides a brief introduction to previous work on libraries and librarians in virtual worlds and with VR and related technologies, and a selection of literature covering the adoption and use of VR and related technologies in public and academic libraries in the United States and South Korea. For further reading on the use of

1) https://secondlife.com
2) https://communityvirtuallibrary.org
3) https://simtk.org/projects/opensim
4) https://www.uncensoredlibrary.com/en
5) https://www.minecraft.net

VR in these and other types of libraries and cultural heritage institutions, please see Figueroa (2018), Varnum (2019), and Bekele et al. (2018).

2.1 Libraries and Librarians in Virtual Worlds

Librarians and libraries have been active in virtual worlds, such as Second Life, for almost two decades. Within virtual worlds such as Second Life and Kitely[6], librarians have created virtual libraries and offered a wide variety of digital collections of e-books and other electronic media as well as virtual reference services (Chow et al, 2012; Dey, 2012; Grassian & Trueman, 2007; Hill, et al., 2017; Mon, 2012; Parry, 2008; Webber & Nahl, 2011). Virtual worlds and virtual reality have also been used in Library and Information Science education to train pre-service librarians in skills they need for the real world as well as the virtual world (Condic, 2009). VR has also been used for educating library users about how to use library collections and services (Chen & Tasi, 2012; Lim, 2021; Tudin, 2016).

2.2 VR, AR, MR, & XR in Public Libraries in the United States

Kim et al. (2021) showed that as of 2020, 11 U.S. public libraries provide VR services (mostly contents for travel and exploration) that allow users to wear actual HMD gear and controllers and participate in serial sessions (not one-time base trial). In most public libraries, users need to take the librarian-led VR training session or certificate prior to participating in the session and minor users (children and teenagers) should submit the consent form signed by their parents (Kim et al., 2021). Kim (2020) notes that most libraries using VR and related technologies are supplying access to existing VR content and hardware, and that there is a need for more accessible and high-quality content.

Clark (2019), a new media librarian at a Public Library in Illinois, describes and explains how their library used various VR hardware and software to support a neutral and informal learning environment. Clark (2019) suggests that libraries can use the high market penetration and ownership of smartphones to provide access to XR content and applications without needing to invest as much into their own infrastructure, at least for those who have access to smartphones. Clark (2019) also argues that free and open standards and technologies, such as WebWR (now WebXR Device API[7]) are important for sustainability and accessibility of XR content.

Through interviews with public librarians in the Washington State area, Lee et al. (2020) found that while public librarians saw the educational potential and social value in VR, there were challenges, such as lack of suitable VR content, space limitations, privacy concerns, limited accessibility for those with physical or cognitive disabilities, among other reasons. Lee et al. (2020) argue that librarians need to think carefully about how they define marginalized communities in their local contexts when planning, promoting, and assessing the success of their VR programs. They also

6) https://www.kitely.com
7) https://www.w3.org/TR/webxr

suggest that librarians should plan alternative ways for users with mobility or cognitive issues to engage with VR content as well as consider meaningfully engaging their community to support them in creating their own relevant VR content. Continuing from the previous study, through surveys with librarians and patrons who participated in drop-in VR programs at several public libraries in Washington State, Dahya et al. (2021) found that most of the patron participants were white boys or men or had previous experience with video games, suggesting that the interest or appeal of VR library programming may be demographically limited and that libraries and librarians may need to rethink how to market and engage diverse and marginalized parts of their library communities.

2.3 VR, AR, MR, & XR in Public Libraries in South Korea

As information communication technologies of Big Data, Artificial Intelligence (A.I), Cloud Computi ng, and Internet of Things (IoT) were rapidly introduced into the library setting, Library and Information Science researchers found that both users (especially young generation including Y generation, Millenni als, or Z generation) and librarians have high interests and demands in next generation digital library services of makerspace, big data, AR/VR, 3D printing, digital textbook, RFID and others (Noh, 2014a; Noh, 2014b; Park et al., 2018). To extend the nature and scope of traditional user programs in libraries for the Post COVID-19 era, public libraries should increase provision of educational, recreational, and cultural user programs using VR/AR/MR technologies along with other online services (Noh et al., 2020).

Libraries have started to adopt immersive media-based reading programs for children's reading promotion such as interactive storytelling and AR/VR books (National Library for Children and Young Adults, 2020). As of 2020, 19 out of 1,134 public libraries provide VR services (Kim et al., 2021). Most public libraries offer one-time services for young kids, juvenile users, and their family that they mainly use Smartphone, Google Cardboard, and Kits (only few VR headsets or HMDs) to teach them the concept of Virtual Reality and utilize VR for operating subject specific programs such as reading VR books, drawing webtoons, and DIY VR and VR games (Kim et al., 2021). This research suggests that public libraries should provide serial VR services at a regular time interval for maximizing immersive interaction in the areas of Explore (e.g., Nature, Universe), Create (Interaction with virtual objects), Learn (Combination of Explore and Create), and Play (e.g., Games) by letting users experience VR headsets and controllers (Kim et al., 2021). To conduct sustainable VR service in the library, it is critical for librarians to obtain, design, and run quality educational programs as well as they need to take proper training to enhance their knowledge and competencies using VR technologies (Park et al., 2018; Kim et al., 2021).

2.4 VR, AR, MR, & XR in Academic Libraries in the United States

As of 2020, 44 out of 116 Academic Research Libraries (ARLs) member university libraries provide AR or VR services (Lee & Chung, 2020). Through surveying websites of forty-four university libraries, they mostly hire multiple librarians and technicians and provide VR services as forms of checking out VR headsets and spaces for courses, research, and one-time experiences, offering educational and consulting sessions for VR content development as well as demonstration (Lee & Chung, 2020). Like Clark (2019) above, Hahn (2017) describes a variety of VR technologies and how they can be used for research and teaching in the academic library context. Hahn (2017) explains that VR can help provide first-year experience training for new students, use MX headsets like the Microsoft HoloLens[8] for immersive e-books readings, virtual visualization of statistical data and analyses, as well as a part of library makerspaces. Hahn (2017) notes that academic librarians should try to keep up to date on new developments on this rapidly evolving area using popular media sources, such as The Verge[9], Wired Magazine[10], or eWeek[11], which could also help them discover or think of new ways to use VR technologies. Hahn et al. (2019) describe how academic libraries can support and sustain virtual reality applications across institutions and departments by archiving 3D and VR content, offering instructional and design support to faculty who want to teach with VR as well as faculty and students interested in using VR for research or content development.

In assessing whether to expand their VR technologies collections and services, Frost et al. (2020) conducted a survey and focus group with the library users at Brigham Young University. While most of their VR users were male students majoring in STEM fields, they also found that students from all backgrounds as well as faculty from the Arts & Humanities and Social Sciences were using the one VR headset on offer, an HTC VIVE system[12] usable only in the library. They found enough use and interest to invest in more VR technology and plan to circulate it if possible. While academic use of their VR was lower than expected, they plan to market their VR technologies more widely across their campus and different departments knowing it had a broader appeal based on their survey and focus group findings. Hannah et al. (2019) argue that VR and AR technologies should be used in academic libraries to support the Humanities and Social Sciences and describe a collaboration between the academic libraries and College of Liberal Arts at Purdue University that is planning a repository for 3D content. They argue that VR and AR technologies could be leveraged to forge new interdisciplinary collaborations across campus and that libraries should anticipate and be ready for change.

Colegrove (2018) describes lessons learned from the DeLaMare Science & Engineering Library at the University of Nevada, Reno, where AR and VR technologies were added to the lending collection to allow for circulation and use outside the library. Colegrove (2018) notes that they

8) https://www.microsoft.com/en-us/hololens
9) https://www.theverge.com
10) https://www.wired.com/magazine
11) https://www.eweek.com
12) https://www.vive.com/us

created detailed cataloging records and procedures for checking and cleaning the equipment upon return as well as some tips, such as using VR headsets with replaceable foam face interfaces for easy sanitation and built-in earphones for better usability, and cable management systems for more permanent setups. Colegrove (2018) noted that the circulated equipment helped support more interaction with the computer science and engineering faculty members, new course development, and installation of permanent VR and AR spaces in the library. There were persistent challenges related to the prohibitive costs and new technology developments needed to make full use of the technology, as well as software licensing and security issues.

Examining VR programming and services within the academic libraries at Temple University and the University of Oklahoma Clark, and Lischer-Katz (2020) identified several concerns for ensuring the accessibility of VR programs and services to disabled users. They suggest that librarians should plan for accessibility from the start; be aware that there may not be accessible VR standards and to seek other related standards or establish their own; have developer support that is available and knowledgeable of accessibility issues; include means for collective feedback and assessing user experiences; to use VR as a means to an end rather than the main focus; and to be aware of the accessibility limitations of VR and be able to provide alternative experiences and options (Clark & Lischer-Katz, 2020, p. 8).

VR and related technologies seem to have been adopted in medical and health sciences specialized academic libraries across the United States (Moore et al., 2018). For example, through collaborations with surgeons, doctors, nurses, and researchers, librarians at the Health Sciences Library (HSL) at the University of Washington established a room-scale virtual reality space, called the Translational Research and Information Lab, TRAIL) to facilitate cardiothoracic pre-surgical consultations (Bardyn et al., 2018). Napa et al. (2019) evaluated two of the VR apps developed through collaborations in TRAIL and explored the librarians' roles in the process. Napa et al. (2019) found that while some clinicians were unsure how the librarians could support the collaborations, some suggested that librarians can help the clinicians by creating repositories of VR images for training purposes as well as facilitating and maintaining the VR technologies and space. Relatedly, Lischer-Katz et al. (2019) found a variety of issues affecting the curation and preservation of 3D and VR data in academic libraries ranging from documentation, ethical and legal issues, and research transparency and reproducibility. They address these issues, they recommend involving a diverse stakeholders and software engineers when drafting preservation plans, make system purchasing or designing decisions based on future compatibility, to keep up to date on digital media preservation practices from related fields, and to take a lifecycle approach to handling 3D and VR data.

2.5 VR, AR, MR, & XR in Academic Libraries in South Korea

It is an early stage of libraries adopting VR services in Korea and university libraries are leading parties with most resources. Lee and Chung (2020) shows that only 4 university libraries in Korea have adopted and provided VR services including one time trial based user programs, library tours, training programs to support VR content creation, and checking out VR software/hardware (HMD gears, VR ready PCs, Screen, Content Creation Software such as Unity, Unreal, etc.) and spaces

as well as consulting programs for applying VR technologies to specific course contents or research. From surveying university students who visited and used VR services, Lee and Chung (2020) shows that users are mostly satisfied with the facilities (devices and spaces) and quality of VR contents they used, they are relatively unsatisfied with the level of technical expertise of librarians or service staff. However, the study shows that users express high prospects for using VR technologies and related library services for their future education, research, and career development (Lee & Chung, 2020). Kwon (2019) also investigated college students' perception, experience, and needs for VR services and addressed that students' interests in VR technologies are high while understanding of the VR technologies is relatively low. In addition, most students (74%) experienced the VR technologies for entertainment purposes at PC cafes while they attended user programs at libraries and or museums (4%). Regarding their preference for VR contents that libraries (regardless the types of libraries) can provide, students choose technologies such as Engineering, Medicine, Natural Sciences as well as Humanities, Social Sciences, and Arts to experience active engagement and immersive interaction that is hard to be experienced in real worlds (Kwon, 2019). Kwon (2019) argues that libraries need to develop and provide users with quality educational VR contents so that users easily learn, adopt, and continuously enjoy VR technologies.

Kwon and Koo (2020) surveyed university librarians in Korea and found that librarians currently do not have much previous experience of using VR technologies and thus have little knowledge and skills to employ VR technologies into library services. However, university librarians understand the educational and recreational values of VR services for their users and highly demand opportunities to gain experience and adopt VR technologies into library services (Kwon & Koo, 2020). Regarding the service areas for VR technologies to be used in university library settings, Simulation: experiments and practical training (such as job interview simulation, STEM experiments, and surgery simulation) is ranked in the first place, followed by Library tours and tutorials, Library Materials and Contents for teaching and or research (that can be easily provided in virtual setting), Library User Education (such as reading programs, information literacy education, bibliography education, etc.), and Library User Programs related to arts, music, travel, and other recreational and cultural purposes (Kwon & Koo, 2020).

From previous research regarding VR and university libraries, it is shown that even though both users and librarians are highly interested in and aware of the current VR technologies and services, they have limited experience, knowledge, and skills of using VR technologies. This shows the importance of training newly appointed pre-service librarians and in-service librarians at all types of libraries (Park et al., 2018; Kim et al., 2021; Kwon & Koo, 2020; Lee & Chung, 2020) as well as developing VR related courses in LIS curriculum for educating future librarians in advance (Kim et al., 2021).

3. Method

The research team conducted a summative content analysis of the course titles and descriptions of terminal Library and Information Science programs in the United States and South Korea. Summative

content analysis involves first identifying and quantifying keywords, concepts, or other content in qualitative content and then exploring and analyzing their use and meaning within the research context (Hsieh & Shannon, 2005). Keywords are often based on researchers' purposely selected topics or through a literature review (Hsieh & Shannon, 2005). The selection criteria for terminal LIS programs in the United States was based on their membership in the United States[13] and their American Library Association (ALA) accreditation status, either initial or continued accreditation, as of the data collection period in January 2022. In total, this US sample included 54 ALA-accredited degree programs.

Librarian degrees or other credentials to work as a librarian can be obtained through three sources in South Korea: university programs, specialized educational institutes, and the credit bank system, which offers training from the Korean National Institute for Lifelong Learning (Korean Library Association, n.d.). As with different states in the United States, there are a variety of additional certifications and credentials needed for different types and levels of librarianship in South Korea. To have a meaningful comparison between LIS degree programs in the United States and South Korea, only LIS degree programs offered by universities in South Korea were sampled. As such, a total of 37 Korean LIS degree programs were sampled.

One significant difference in librarian education and credentialing between South Korea and the United States is that while a master's degree is the terminal professional degree for most librarians and information professionals in the United States, a bachelor's degree in Library and Information Science (or Studies) is the primary terminal degree to work as a full-time librarian in South Korea. While master's and doctoral LIS degree programs do exist in South Korea, they are not required to work as a full-time librarian and are pursued for career advancement in leadership or research roles. A comparison between LIS programs in the United States and South Korea is more realistic and meaningful when comparing the curricula of the primary terminal degree. As such, the LIS curricula of ALA-accredited master's programs at universities in the US and bachelor's degree programs at universities in South Korea are described and compared in this manuscript.

Course titles and descriptions and syllabi were collected and analyzed during January 2022. The research team collected this information from the department, institution, or university's websites or course catalogs for the respective LIS degree programs. If publicly accessible, the most recent versions of syllabi of related courses with VR and related technologies in their course titles or descriptions were also collected. The authors only collected and analyzed data that was publicly available on the programs or institutions' websites with the assumptions that they are most likely to be updated by their respective programs and serve as resources for both prospective and current students to explore the curricula or plan their courses of study.

Given the primary topic of virtual reality, the research team carefully explored each website and used keyword searches either through the websites' search functions or simply using the find command (ctrl + F) built into the browser software. The keywords included virtual reality or VR, Augmented Reality or AR, Mixed Reality or MR, and Extended Reality or XR, as well as their

13) This included all ALA-accredited graduate programs in North America, excluding those in Puerto Rico and Canada.

corresponding equivalent terms in Korean. Additionally, course titles and descriptions containing related terms and concepts, such as emerging technology, immersive media, new media, and virtual environments were also collected because VR and related technologies could be included in, if not explicitly stated. The content of the syllabi was analyzed using a combination of open coding and the three key themes identified in the literature review, stakeholder partnerships; content developme nt; and inclusion and accessibility.

4. Findings

4.1 Course Title & Description Content Analysis

Of the 54 ALA-accredited master's in LIS degree programs in the United States, six out of 54 (11.11%) had at least one course covering virtual reality, 4 (7.41%) had at least one course covering augmented reality, 2 (3.70%) covered mixed reality, and 1 (1.85%) covered extended reality. Nineteen (35.19%) programs covered related terms and topics. In particular, 16 (29.63%) covered emerging or new trends or technologies and 3 (5.56%) included courses on virtual environments or communities. Of the courses that covered VR, four were electives specifically on the topic, three were special topic courses focused on VR and AR applications, and one covered VR in the context of makerspaces. Two universities in the US had two courses specifically on VR and AR available; both are iSchools. Additionally, all the LIS programs in the US covering these topics are iSchools. Only programs that covered VR also covered AR, XR, and MR; there were no programs that covered AR, XR, or MR and did not also cover VR.

Of the 37 LIS bachelor's degree programs at universities in South Korea, one out 37 (2.70%) universities had one course covering virtual reality and a different university had one course including augmented reality. Eleven university LIS degree programs (29.73%) included courses on related terms and concepts. More specifically, nine university programs (24.32%) had LIS courses focusing on technology, two university programs (5.41%) had LIS courses covering new media, and one university program (2.70%) had a course on immersive media. One South Korean university had two courses that covered VR, though within courses about digital information services, immersive media, and makerspaces. Another South Korean university covered AR in an information services course. Neither of these universities are iSchools.

The overall findings described above are summarized in **Table 1** below. Given the nature of the nominal data collected and small sample sizes, statistical comparisons are not particularly useful. Chi-squared and Fisher's exact tests did not find any statistically significant differences between the frequency of observations between the US and South Korean samples.

Table 1. VR & Related Topics in Terminal LIS Degree Programs in the United States & South Korea

Country	Program	Virtual Reality (VR)	Augmented Reality (AR)	Mixed Reality (MR)	Extended Reality (XR)	Related Terms (Emerging Technology, Immersive, New, Interactive Media, Virtual Environments)
United States	ALA-Accredited Master's in LIS Programs (n=54)	11.11% (6)	7.41% (4)	3.70% (2)	1.85% (1)	35.19% (19)
Republic of Korea (South Korea)	Bachelor's in LIS University Programs (n=37)	2.70% (1)	2.70% (1)	0	0	29.73% (11)

4.2 Syllabi Content Analysis

The content of the most recent syllabi for courses with titles and descriptions that explicitly mention VR and related technologies were also collected if they were publicly available on the respective institutional websites. Four out of the 6 LIS programs in the United States that included VR or related technologies in their course titles or descriptions also provided public access to their syllabi and none of the South Korean LIS programs provided access to their course websites. Six course syllabi from the 4 XR-inclusive LIS programs in the US were collected and analyzed using open coding and key themes identified from the literature review, as discussed below.

4.2.1 Method of Instruction & Major Coursework

The courses of the syllabi collected were offered between Fall 2019 and Fall 2021, with five out of 6 courses being offered as full-length classes and one as a shorter summer session course. Four of the six courses were fully online, with three being synchronous using video conferencing and one being asynchronous using recorded video lectures with supplemental, non-compulsory synchron ous meetings. Only one course was offered fully face-to-face, though this was the course from Fall 2019, before the onset of the still ongoing COVID-19 pandemic. One of the courses was offered in a synchronous hybrid format, with classes held both via video conferencing and face-to-face in a computer lab in Fall 2021. Two of the courses were a pair of introductory and advanced level courses.

Instructional methods for all included a combination of lectures, assigned readings, discussion, presentations, prototyping, exploration of VR and related technologies, and team-based cumulative or final projects. The cumulative or final projects of five of the 6 courses focused on the design and prototyping of a project using VR or AR, with the other focused on research study, complete with IRB, data collection, analysis, and presentation of the results. Two separate courses included diaries or journaling to document the students' progress on their projects or to reflect on their experiences using various VR and related technologies.

4.2.2 Course Content

All the courses covered or introduced core concepts and theoretical and practical aspects of VR and related technologies. Technical skills such as interface design, user experience research, prototyping, and computer programming were covered. General skills such as collaboration, teamwork, project management and planning, usability testing, evaluation, and assessment were also common. Technical and general skills were taught through direct instruction as well as developed through coursework as described above.

However, there were two contexts in which the courses were presented: general or LIS-oriented. Four of the courses fell into the general context and were more broadly focused on the design of virtual or augmented user experiences, user interfaces, visualizations, and environments. Two of the courses specially presented the content in direct connection with their use and applications within libraries, museums, makerspaces, or other information organizations. These courses presented content and focused coursework on the use and applications of VR and related technologies to provide content, programming, and services to library or information users as well as skills related to needs assessment, cost analysis, and return on investment.

In relation to the three key themes identified in the literature review (stakeholder partnerships, content development, and inclusion and accessibility), all the courses addressed content development. Both LIS-oriented courses addressed issues related to both stakeholder partnerships and inclusion and accessibility. While some of the general courses addressed issues related to stakeholder partnerships and accessibility, such as user experience, usability, evaluation, and assessment, none of them seemed to focus on issues related to inclusion, such as diversity and social justice.

In general, the courses referred to VR, AR, MR, or XR technologies as broad categories when describing course content. However, some of the courses did identify specific software applications, programming languages, hardware, and other technologies that are covered or used in the courses. Of note, Unity was identified in half of the courses. The complete listing can be seen in **Table 2.**

Table 2. Alphabetical Listing of Software, Programming Languages, Hardware, & Other Technologies Covered with Frequencies

Software & Programming Languages (Frequency)		**Hardware & Other Technologies (Frequency)**	
A-Frame (2)	Adobe Aero for AR (1)	360 Video (2)	3D Printing (1)
Adobe Creative Cloud (1)	Adobe Illustrator (1)	Android or iOS	Smartphone (2)
ARCore (1)	Apple Reality Composer (1)	Camera (1)	Game Controllers (1)
ArKit (1)	Blocks for VR (1)	Google Cardboard (2)	Large Display Walls (1)
C# (1)	C++ (1)	Laser Cutting (1)	Microcontrollers/Microc
CSS (1)	Google Tour Creator (2)	omputing (1)	Motion Tracking/Capture (2)
HTML (1)	JavaScript (1)	Oculus Quest or Quest 2 (1)	Other Head Mounted

Sage2 (1)	Tilt Brush (1)	Displays/Headsets (2)	Pocket 360 Mini VR
Unity (3)	Unreal (2)	Viewer (1)	Webcam (1)
		Windows or MacOS PC (2)	

5. Discussion

5.1 Key Themes from the Selected Literature Review

While brief, the selected literature view identified some key themes that could be used to help develop course content and best practices for integrating VR related technologies into libraries and LIS education. Three interrelated themes are discussed below: stakeholder partnerships; content develop ment; and inclusion and accessibility.

5.1.1. Stakeholder Partnerships

Successful adoption of VR and related technologies into libraries and, in turn, the LIS curriculum depends on successful collaborations and partnerships with stakeholder groups, such as librarians, technicians, developers, vendors, students, volunteers, faculty, and other community members. Collabor ations and partnerships between stakeholders can leverage the strengths and overcome the weaknesses of each. For example, if a researcher wants to do VR research but does not have access to or experience with VR equipment and software nor funding to secure, partnering with the library that has the equipment and collaborating with a librarian who knows how to use VR technologies can be beneficial for all involved. Conversely, if a library wants to develop new VR programs or add VR technologies to their collections, they can survey their community to discover needs and use cases to provide more relevant resources and services to their communities. Librarians in South Korea commonly request specialized technical assistance from VR technicians, vendors, and fellow librarians who have much experience and knowledge with VR services (Kwon & Koo, 2020; Park et al., 2018; Kim et al., 2021).

Findings from Hannah et al. (2019) and Frost et al. (2020) suggest that there may be more potential stakeholders from different fields and backgrounds interested in using VR than expected, so libraries should conduct needs assessments to better understand both their current and new potential users. Lischer-Katz et al. (2019) argue that a diverse range of stakeholders should be consulted when developing plans and systems for preserving 3D and VR content to ensure the systems satisfy the stakeholders' requirements over the long term. Relatedly, Napa et al. (2019) found that librarians can contribute to collaborations with researchers and health professionals in medical libraries. This suggests that librarians can be valuable stakeholders and partners with projects and collaborations outside the library. In the South Korean context, academic libraries have excess funding that can be used to secure VR and related technologies and support course development and research projects, which can lead to partnerships and collaborations with new stakeholders (Lee & Chung, 2020).

5.1.2. Content Development

Building quality educational content is key to libraries' provision of sustainable VR services at a regular interval (Kim et al., 2021; Kwon, 2019; Kwon & Koo, 2020). To do so, libraries also need to constantly evaluate their AR/VR services, obtain sufficient resources of budgets and specialized librarians and service staff (Noh et al., 2020; Park et al., 2018). University libraries can strengthen the connection between library services and courses from diverse disciplines on campus (Marshall et al., 2019). University of Washington Health Science Library collaborated with University of Washington Medical Center and developed Virtual Reality in Academic Health Sciences Libraries: A Primer which students and clinical researchers can learn surgical terms and anatomy, hold pre-surgical consultations, and simulate cardiovascular surgeries (Moore et al., 2018).

Engaging stakeholders can be an excellent way to identify and develop content. In Canada, McGill University Libraries (2020) inform library users that various disciplines can employ VR technologies into coursework and research: Archeology (to walk around 3D visualizations or reconstructions of archeological sites), Architecture (to build, analyze, and interact with models of rooms or buildings), Engineering (to view and understand designs in 3D), Medicine (to practice surgeries and visualize anatomy), Art (to view and create artworks from different angles), Psychiatry (to run simulation to help reduce anxiety), Journalism (to immerse in the news and stories), and many others. Academic libraries need to reach out across departments and disciplines to users, students, and faculty members who have interests in employing VR to their courses or for research. This can help identify VR content to add to the library's collection or lead to new collaborations that create new VR content. The more relevant and useful content that is available, the greater the possibilities for collaboration and long-term use.

5.1.3. Inclusion and Accessibility

Expanding accessibility and improving inclusion to VR technologies, programs, and services are vital. Frost et al. (2020) and Dahya et al. (2021) found that while many VR users in their libraries were white and male, there was still a lot of interest in other demographic categories. Dahya et al. (2021) and Lee et al. (2020) suggest that librarians and libraries may need to do more community outreach and marketing to parts of their communities that are marginalized. Libraries and librarians should work to identify and include marginalized community members, such as Black, Indigenous, and people of color, LGBTQIA+ persons, the economically-disadvantaged, mobility or cognitively disabled persons, and seniors, when developing, marketing, and providing access to collections, programs, and services related to VR and associated technologies.

5.1.4 Uniting the Themes and the Content Analysis

Tying back to the other themes above, engaging with marginalized parts of the community can help gain meaningful stakeholder feedback and involvement and provide inspiration and sources for VR content that the community members want to use or make. Of course, there are other

issues associated with VR and related technologies that libraries, librarians, and LIS educators should be concerned about, such as health and safety, security and privacy, cost, among other ethical and legal issues. However, engaging and interacting with diverse stakeholders and community members can help ensure transparency and involvement in addressing and solving these issues. LIS curricula on VR and related technologies should consider covering these themes.

Based on the limited sample of course titles, descriptions, and syllabi above, it appears that while many of the existing courses address issues related to content development, few address the critical issues and content related to stakeholder partnerships or inclusion and accessibility. Other scholars have noted this trend as well. For example, Gibson et al. (2018) found that foundational LIS courses at top LIS programs in the US offered little if any coverage of critical race theory or other critical cultural theories. Cooke et al. (2016) argue that critical cultural theories will need to be embedded throughout LIS curricula to promote social justice and cultural competency in LIS scholars, educators, and practitioners. Further research on how to incorporate VR and related technologies and social justice perspectives into LIS education is needed.

5.2 Discussion of the Curricula Content Analysis Findings

As mentioned above and given the small sample sizes, it does not appear that the observed occurrences of VR, AR, MR, or XR between terminal LIS degree programs in the US and South Korea are meaningfully different, statistically speaking. Overall, there are few courses that cover VR, AR, MR, or XR in terminal LIS programs in either the United States or South Korea. However, there were some observed differences in how the topics are offered in courses between the United States and South Korea. In the United States, most of the courses covering VR, AR, and related topics are established electives specifically focused on the topics whereas the courses in South Korea covering VR and AR were broader in scope, not specifically or solely focused on VR, etc. There were also a few special topics courses in the United States and seemingly none in South Korea at the time of data collection. Special topics courses are commonly used to pilot new course topics and designs prior to officially adding them to the curriculum, which often involves a lengthy approval process given academic bureaucracy and curricular standards. As such, it could be expected to see more special topics courses in the US and South Korea on VR, AR, and related subjects before more permanent electives are established or approved.

The observation that all the terminal LIS programs in the US that cover VR and related technologies are iSchools and that neither of two South Korean universities can be explained simply because the iSchool movement originated in the US and expanded more rapidly there than in South Korea. Cross-referenced with the iSchool's directory, the research team found that thirty-five of the 54 (64.81%) of ALA-accredited LIS programs in the United States are iSchools, while just six out of 37 (16.21%) university LIS programs in South Korea are iSchools[14]. The iSchools movement represents a shift in LIS programs from a primary focus on librarianship to the broader information

14) There are seven iSchools in South Korea in total, as of February 2022. However, one is not an LIS department nor offers a terminal LIS degree.

professions to be more responsive to nascent trends related to technology and industry (iSchools Inc, 2017). As such, it could be reasoned that iSchools are more likely to embrace and integrate VR and related technologies into their curricula. However, just 6 (17.14%) of the 35 US iSchools in the sample covered VR. In addition to the other findings, this suggests that course development on VR, AR, MR, and XR are still in the preliminary stages.

As mentioned in the literature review, VR technologies and hardware are expensive and may be perceived as a trend or fad that may pass (DuBose, 2020). At least two of the courses covering VR are within the context of makerspaces, which may suggest those institutions have or have access to a makerspace with VR and other technologies already available. Additionally, given the cost and hardware requirements, it may not be affordable or feasible for students to afford or access the technology. Given the ongoing pandemic, students may not have been able to access VR hardware on campuses because of social distancing guidelines and online classes or other issues related to budget and supply chain. Some institutions may be using the special topics courses to gauge interest in the topic or whether VR becomes more widely adopted before investing in the related equipment and course development.

As Ball (2021) noted above, VR is sometimes mistakenly conflated with video gaming. While negative claims about games and gaming persist, games, even recreational ones, have been found to promote a variety of valuable digital literacy skills and pro-social behaviors (Gee 2003; Gee, 2009; Galarneau & Zibit, 2011; Martin, 2011; Martin & Steinkuehler, 2010). These negative perspective s may, if held by librarians, library administrators, LIS educators, lead to disinterest or ignorance in adopting VR and related technologies if their value is misunderstood or dismissed. Greene and Groenendyk (2018) argue that the overlap between or fusion of the entertainment and educational content and experiences enabled by VR and AR technologies can allow for innovations for education, research, and beyond. Of course, library collections are not just for professional, academic, or nonfiction resources. Nicholson (2013) notes that games and other recreational media have been common in US libraries since the mid-nineteenth century.

Relatedly, previous related research found that while gaming is a global, multibillion dollar industry and prevalent in public libraries across the US (Nicholson, 2009), games and gaming are not a common topic in LIS curricula in the United States and that LIS educators that had more gaming experience and experience with multiple genres of games, among other reasons, were more likely to include or use them in their classes (Elkins & Hollister, 2020). According to adult learning theory, also known as andragogy, adult learners, like most LIS students, are more interested in learning new topics if they can relate to existing interests or can understand the value of learning more about the new topic (Taylor & Kroth, 2009). By exposing games and explaining their educational value to pre-service librarians during their coursework, they were more likely to understand their value as part of the library and curriculum (Martin & Martinez, 2016). If these trends are the same for virtual reality and other related technologies, then their inclusion in the LIS curriculum could help new librarians and information professionals to be ready for new adventures into the metaverse using VR.

Regarding Library and Information Science (LIS) led course development, building information and digital literacy instruction programs such as VR-based library tours, VR-based reference service,

VR-based reading programs could be an appropriate place to start (Chow et al., 2012; Mon, 2012; Kwon, 2019; Sample, 2020; Smith, 2019). Kwon (2019) recommended that libraries should provide VR-based information literacy educational programs and various information services and Sample (2020) showed that AR/VR-based information literacy instruction programs (VR tours) reduced library anxiety in international students and returning or nontraditional students. Despite high interest in VR among librarians in South Korea, most do not have sufficient knowledge of or exposure to VR technologies. As such, Kim et al. (2021) and Park et al. (2018) advocate the development and opening of courses and training programs about VR and related technologies for pre- and in-service librarians in South Korea. Given the findings above, the authors would extend this argument to terminal LIS programs and professional development training in the US as well.

5.3 Limitations & Future Work

In addition to the nature of the study and small sample sizes, there are other limitations of this study. Data was collected from the respective institutional websites during January of 2022. As with all websites, the information on the websites could have been out-of-date or updated after the data collection period. As such, future work on this area could revisit and compare the curricula after another year to see if there are new trends or technologies. Similarly, the findings above are limited to the course titles, descriptions, and syllabi that were publicly available. While course titles and descriptions were accessible on each of the websites of institutions sampled, the course descriptions on the websites could be shorter than their counterparts on course syllabi, and syllabi were not readily available nor accessible on many of the websites. Given resource constraints of this study, collection of all the syllabi that were not publicly available was not feasible. As such, future work should include a more comprehensive collection and analysis of course syllabi as well as surveys, interviews, observations, or focus groups with LIS educators, scholars, and practitioners and on their views and use of VR, AR, MR, XR, and other immersive technologies. Further exploration and description of these areas could help develop an educational framework, model, or curricular standards and identify more evidence-based best practices. Additionally, the scope of the above literature review was limited due to scope and space requirements. Future work could also include an expanded, more comprehensive review of research and professional literature on VR and related technologies in libraries and LIS education.

6. Conclusion

Despite interest and use of VR and related technologies in libraries, the results of this study indicate that few terminal LIS programs in the United States and South Korea incorporate it into their curricula. However, with lowering costs and greater accessibility of VR, AR, MR, and other XR technologies as well as the advent of the Metaverse and Fourth Industrial Revolution (Schwab, 2016), librarians, libraries, and LIS educators may develop greater interests in and incentives to adopting them into their classrooms and libraries. As seen in the selected literature review, there

remain a variety of challenges and issues with using VR and related technologies in libraries that librarians and LIS educators and scholars should be aware of and work to address. As seen in the summative content analysis, while existing courses cover content development well, there are opportunities to revise existing or develop new courses that more adequately address issues related to stakeholder partnerships or inclusion and accessibility. LIS practitioners, educators, and scholars can leverage their existing knowledge, experience, and research on these and related areas (such as collection development, community outreach and marketing, data curation and preservation, digital archiving, human computer interaction, social computing, user experience, virtual information services, information architecture, makerspaces, etc.) to position their programs to be ready for the coming changes in the media and technology landscape and better prepare their graduates for successful careers in the 21st century. Virtual and other extended reality technologies can and should be a real reality for LIS curricula.

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