The Potential of AR and VR technologies in Reshaping the Future of Reading

Ana-Maria OSADCI-BACIU

National University of Political Studies and Public Administration
30A Expozitiei Blvd., District 1, 012104 Bucharest, RO
osadci.ana-maria@student.facultateademanagement.ro

doi: 10.25019/STR/2024.034

Abstract
The current business environment is characterized by rapid and sometimes unexpected technological advancements, which contribute to the overall market turbulence, increased competition, and the need for continuous improvement and innovation. This leads to structural changes and a need for innovation across industries. The book market, too, is currently facing massive challenges and rivalry from other entertainment industries that are taking over the market share. In such market conditions, innovation becomes a necessity. This paper explores how augmented reality (AR) and virtual reality (VR) technologies can be applied to the book market to enhance the reading experience and take it to a whole new level of immersion, akin to the stimulating experience of video games or movies. This study aims to investigate and map the research trends and keyword co-occurrences related to integrating AR and VR technologies in the book market and reading-related experiences. Patterns and critical themes in the scholarly approach are explored to understand the direction of the research, a signal of what could become everyday practice or the development of mass-consumption products. VOSviewer is used to visually represent keyword interconnections and research directions in this realm at the intersection of technology and literature. This study contributes to the ongoing exploration of how AR and VR can be applied in different fields, with a particular focus on books. The study provides valuable insights for companies involved in publishing and AR/VR development, as well as for individual practitioners, policymakers, and researchers in this field.

Keywords: *Augmented Reality, Virtual Reality, Book Market, Books in Fiction; Reading Experience, User Experience, Innovation*

Introduction

It is often considered that change is the only constant in this world. There is much truth to this statement, especially in the current world, defined by rapid technological, cultural, political, and overall paradigm shifts (Taleb, 2012). The book market and reading as an educational and leisure activity have always been sensitive to socio-cultural realities but also to technological advancements. At the same time, their direct and especially indirect effects on society and the economy are remarkable (Bloome, 1985). Back in time, Johannes Gutenberg's invention of the movable printing press made reading available to the masses, which had a significant impact on society. The increase in reading accessibility and popularity led to better, more accessible education, increased innovation, automation, industrialization, and improved working conditions, such as shorter working hours and reduced child labor (Galor, 2022). These are indirect macro-level effects. At the individual level, reading has direct effects like increased brain

connectivity (Horowitz-Kraus & Hutton, 2018), empathy, logical thinking, and creativity (Kuzmičová, Mangen, Støle, & Begnum, 2017; Danaei, Jamali, Mansourian, & Rastegarpour, 2020), which lead to aggregated social effects.

Ever since, the popularity of leisure reading has fluctuated but now faces competition from various other forms of media, such as gaming, social networks, video podcasts, and movies. With the fast pace of modern life, multiple entertainment industries are vying for people's attention and available time. Book-producing companies can increase their market share by collaborating with alternative entertainment industries instead of viewing them as competitors (Peltoniemi, 2015). This is especially true regarding technology, which has a novelty effect on people and is even perceived as "magic" by children (Yilmaz, Kucuk, & Goktas, 2017). In today's world, technology has become an integrated part of our daily lives. The book market has adapted to these changing realities by adopting digital business models and products such as e-books, audiobook platforms, book-related podcasts, and summaries (Döring, Müller, Rohr, Ruhrmann, & Schäfer, 2022). However, more sophisticated digital technologies, such as AR and VR applications, are still in their early stages in the book industry. These applications are very promising both from an educational and a leisure perspective. Such technologies can be used for educational purposes, enhancing reader engagement and experience, or helping people with reading difficulties to have a more effective and enjoyable reading experience. It is quite probable that just as smart devices have, augmented reality and virtual reality will become a part of our everyday lives across domains (Rauschnabel, 2021). Exploring and understanding the possibilities they deliver is crucial for the publishing sector to thrive and become intertwined with other industries.

Interestingly, long before AR and VR technologies could be applied to transform books, the idea of such alternative technologies also appeared in books and in other narrative-related art, such as movies and comic sketches. For instance, multiple futures, where technologies such as augmented reality, virtual reality, or something similar to the metaverse have been explored in SF books since the very beginning of the computer age and even before. For example, "Snow Crash" (Stephenson, 1992) and "Ready Player One" (Cline, 2011) both depict the future of media, including books, as occurring in a virtual realm or simulation. The notion of "augmented reality" and its implications are extensively discussed in Vernor Vinge's novel "Rainbows End" (2006), in which future humans appear to interact with virtual overlays of reality almost constantly through specialized eyeglasses. Literature, games, and other informative or leisure media are experienced in this manner. Perhaps one of the narratives where AR technology, with AI implications, is most thoroughly explored, especially in the domain of education, is "The Diamond Age: Or, A Young Lady's Illustrated Primer", also written by Neil Stephenson (1995). For example, the idea of *smart paper* that can display personalized news headlines appears in this work. One of the central elements of this novel, implied by its very title, is an interactive book called "Young Lady's Illustrated Primer: a Propædeutic Enchiridion". This volume functions as a good behavior manual designed to instruct its reader on how to adhere to this futuristic society's rules and become a valuable member of the community. It acts as a kind of educator and personal assistant, a guide engineered to interact with its owner's surroundings and help them survive and integrate into society. These examples show how human imagination in the artistic and cultural realm often precedes, anticipates, and, possibly even inspires technological advancement. This makes the study of these technologies and their applications in the book market even more interesting from the standpoint of imagining new futures and perspectives.

The main objective of the current research is to investigate the present trends in integrating AR and VR technologies into the book market and reading activities. The study explores the industry's implications, potential real-life applications, and future research trends. Additionally, the research examines the potential of AR and VR to enhance the reading experience, including its cognitive and emotional impacts, learning outcomes, educational benefits, user engagement, and satisfaction. The paper seeks to provide practical recommendations to publishers, authors, educators, and technology developers on effectively leveraging AR and VR to enhance the reading experience.

Literature review

Technology has had a significant impact on almost all aspects of our lives in the last few decades, transcending industry sectors and geographical boundaries. The evolution of technology is characterized by long periods of stability and continuity, which are occasionally interrupted by short bursts of discontinuous, radical change (Hung & Tu, 2011). Augmented and Virtual Reality applications are the next possible paradigm-shifting technological innovations with massive potential in society. These applications are already being produced and used on a large scale in industries and businesses for training, simulation, design, remote collaboration, and other purposes. However, at the consumer level, their adoption is more gradual due to the high prices of high-end applications, currently mostly used in gaming (Aukstakalnis, 2016).

Augmented Reality and Virtual Reality technologies have found their way into various fields, includingthe book market, where they have been proven to increase motivation, engagement, and enjoyment (Cheng, 2017). Such devices are often associated with excitement and a positive emotional state, which directly impacts the learning experience. Positive feelings activate our ability to recall and comprehend a situation or lesson (Johnson & Rosenbaum, 2015; Pianzola, Bálint, & Weller, 2020). This is why these applications have been widely used in the educational setting, especially for children with neurodivergent conditions, learning disabilities, or impairments, and have proven their usefulness (Flores-Gallegos, Rodríguez-Leis, & Fernández, 2022). However, it is important to note that too high a level of enjoyment can often lead to decreased concentration and learning abilities, so, for educational purposes, such applications need to be carefully designed (Yilmaz, Kucuk, & Goktas, 2017).

It is worth mentioning that AR and VR applications are also having a significant impact in other industries related to culture and education. For example, an AR application in the publishing sphere is connected to tourism materials, such as books or albums, where users can explore landmarks, virtually navigate cities, view images and videos, or even receive real-time information about the places. This would provide a preview of the travel experience. At the same time, AR can enhance the traveling experience through multimedia travel guides, allowing users to access videos, audio guides, interactive maps, information on historical context and stories, or even additional features such as language translation (Cranmer, tom Dieck, & Fountoulaki, 2020; Özkul & Kumlu, 2019). Likewise, many museums are using AR apps as virtual guides, with QR codes in each room and the possibility to discuss various exhibitions in the museum. Museums also adopt VR technologies for immersive virtual tours, allowing people to visit some of their collections and exhibitions from anywhere in the world (Bira, Zbuchea, & Romanelli, 2020; Zbuchea, Bira, & Balan, 2025). Some examples are the National Museum of

Modern and Contemporary Art in South Korea, the Van Gogh Museum in Amsterdam, and the British Museum in London (Romano, 2024). An interesting example is the Louvre's VR experience project "Mona Lisa: Beyond the Glass", where visitors can meet the woman behind the painting and see Leonardo da Vinci's working process by getting transported back in time to the original setup via VR technology (Louvre, 2021). Indeed, VR is increasingly used to recreate historical events and places, allowing visitors to museums and historical sites, as well as students in history-related fields, to experience history firsthand.

A project worth mentioning is "Rome Reborn", where VR is used to reconstruct ancient Rome. With each revision, the VR projection looks more and more realistic based on *visitors*' and developers' feedback (Marshall, 2023). AR and VR usage is also highly relevant in music; for instance, piano lessons are available in mixed reality environments. A key feature is that, using a VR headset, the piano student can see the notes projected directly onto their real-world piano keyboard (Magic Keys, n.d.). Likewise, entire game-like VR simulations in which one can learn to play the piano exist (Reality Remake, 2023). All in all, the integration of AR and VR technologies in cultural industries is revolutionizing how we experience art, history, music, and other arts, offering immersive and interactive experiences that were once unimaginable. It is very probable that in the future such applications will become integral to various educational settings and even leisure activities.

Going further to book industry applications, Augmented Reality books generally look like regular printed books, but when connected to a computer or smart device, they display superimposed AR elements that transform 2D pictures into 3D virtual objects and animations on the computer screen or with the use of special glasses. AR-enhanced elements are linked to higher story comprehension performance, especially when audio and visual elements are used and when the story is read aloud (Danaei, Jamali, Mansourian, & Rastegarpour, 2020). Multimedia generally fosters story comprehension because it requires less decoding effort than reading printed books. This leads to better absorption of the meaning of the story's elements and an increased ability to relate new information with prior knowledge and make inferences (Panchenko, Vakaliuk, & Vlasenko, 2020). AR also helps readers remember details, episodes, and sequences better than when reading classically. It is important that AR content remains connected to the storyline and does not serve a decorative or distracting purpose (Danaei, Jamali, Mansourian, & Rastegarpour, 2020). The use of technology in the learning process also leads to increased motivation to learn. The successful implementation of augmented reality (AR) in curricula heavily relies on the teaching strategies and instruction provided to teachers and educators. The educational experience, conceptual foundation, and the support received from the institution are crucial factors that determine the effectiveness of AR integration (Panchenko, Vakaliuk, & Vlasenko, 2020).

There are fewer Virtual Reality applications in the book market compared to augmented reality applications. However, VR has the potential to enhance and promote reading. VR is known for adding value when it comes to transporting users into narratives, such as in video games or cinematography. It is important to note that VR experiences are very close to reality and can have a profound impact on the psyche of users. In fact, there have been cases of traumatic responses after experiencing aggression or near-death experiences in VR (Dooley, 2017; Schmidt, Ehrenbrink, Weiss, Voigt-Antons, Kojic, Johnston, & Moller, 2018).

VR can be applied to the reading experience in various ways, with different levels of immersion. For example, a less immersive way of reading in a VR environment, where the VR has the role of a background setting, is to replicate the real-world reading but in the virtual environment. The benefit of such a type of reading would be that the user is completely detached from the real-world distractions as they read with the VR glasses on (Pianzola, Bálint, & Weller, 2020). In such cases, the text parameters, such as fonts, colors, and distances, are essential for user experience (Kojic, Ali, Greinacher, Möller, & Voigt-Antons, 2020). The immersion element is peripheral, and it is enhanced by surrounding the text with backgrounds similar to the information read (Pianzola, Bálint, & Weller, 2020).

Enhancements in audio and visual elements can significantly increase a user's immersion. For instance, users can listen to an audiobook in VR while being completely isolated from the real world (Hutchison, 2018). The visual elements can be animations, additional information, characters from the book that users can interact with, or mini video games during reading pauses. Studies in the educational sector have shown that after reading in virtual environments and analyzing different 3-D objects, participants played related short games that improved their comprehension and memory recall (Flores-Gallegos, Rodríguez-Leis, & Fernández, 2022; Rooney, Burke, Balint, O'Leary, Parsons, Lee, & Mantei, 2017). Deeper immersion levels have also been found to enhance empathy towards characters in fiction, narrative absorption, and transportation, providing cognitive and affective benefits to readers (Kuzmičová, Mangen, Støle, & Begnum, 2017; Pianzola, Bálint, & Weller, 2020; Rooney, Burke, Balint, O'Leary, Parsons, Lee, & Mantei, 2017).

The most immersive VR application in the reading experience is located at the intersection of reading and cinematography. It is a fully immersive experience, generally designed for short stories, that offers a cinematic experience where the user becomes a participant in the story, even allowing them to choose different story paths. Initially, such applications were used in documentary or journalistic work, but nowadays, the focus has shifted towards the storytelling experience. Such applications, where the level of immersion is high, pose challenges from several viewpoints for the writers and developers. There is tension between interactivity and dramatic structure, as a core structure needs to be maintained to have a comprehensive storyline. Another concern is that such deep engagement, accompanied by massive levels of stimulation and strong emotions, can have adverse effects on the psychological health of users if the experience lasts for too long (Dooley, 2017). Entire books cannot be experienced this way. However, it is an interesting application for short stories or for book teasers.

From a commercial inroads' standpoint, AR books have already penetrated the market in the area of children's books and education-related books and materials. From literary classics like "Moby Dick" to educational titles like "Solar System Augmented Reality Activity Book", AR technology is being applied across various genres and subjects. Popular examples include "Wonderbook: Book of Spells", by J. K. Rowling, which allows readers to cast spells from the Harry Potter universe, as well as the children's book "Little Mermaid" that brings stories to life with smartphone-enhanced animations and games, and "Monsters Inc.", an interactive book based on the animation with the same name. An interesting example of how publishers are leveraging AR in education to make complex subjects more accessible and engaging is the PlanetARy Book Series. Such AR-

enhanced books can stimulate curiosity and make the time children spend in front of screens more meaningful and informative (BrainSTEAM Education, n.d.; Stroies AR, n.d.). VR books have not yet seemed to penetrate the market, but there is much research related to how VR environments stimulate reading activity, and there are some prototypes used in research frameworks. This emerging field shows promise for enhancing reading experiences and learning outcomes, though it is still in early stages of development (Troscianko et al., 2021; Radianti et al., 2020; Sumardani & Lin, 2023).

Until recently, augmented reality (AR) and virtual reality (VR) technologies were used separately. However, with the help of newer technology, Mixed Reality (MR) environments are now created, and they combine real, augmented, and virtual realities within the framework of the Reality-Virtuality Continuum. This concept allows for multiscale and multimodal use, where the boundaries between the virtual and physical worlds blur. It offers to users a rich, multisensory experience that is both captivating and transformative (Farshid, Paschen, Eriksson, & Kietzmann, 2018). There are already such applications in the book market as well. A prototype called Magic Book has been created, which allows for different levels of immersion and content or information discovery and experience. It uses a physical book product with AR superimposed on its pages, and an additional level of VR immersion by using VR-specific technologies (Panchenko, Vakaliuk, & Vlasenko, 2020).

It is important to note that there are certain disadvantages or cons in implementing these technologies on a large scale or moving them to the mass market. Hence, their scarce use at the current moment. One important disadvantage is the cost associated with the devices used in AR and VR technologies, especially when it comes to VR, such as headsets or goggles. Additionally, in the context of reading and learning activities, there is a significant lack of unified application standards, as well as of resources and software systems that are long-term, well-suited to these technologies. For instance, desktop VR, which is more commonly used for reading and learning, often does not fully deliver the benefits of a VR experience. It is worth noting that this technology originated outside education, primarily in entertainment, so adapting it for educational purposes requires careful consideration. For example, if used in an educational reading context, there might be a risk that users become too drawn into the virtual environment, affecting their attention span and impeding proper learning and understanding of the material, especially if the virtual environment contains too much unrelated/*noise* content. Moreover, using immersive VR/AR devices for long periods can cause discomfort like dizziness in users (Qiu, Chiu, Zhao, Sun, & Chen, 2021). Finally, the present state of research does not have sufficient practical applications or tests to fully understand, in a context of reading, how various factors such as immersion, higher-order cognition, learner emotions and empathy, and other neuro aspects interact (Danaei, Jamali, Mansourian, & Rastegarpour, 2020; Pianzola, Bálint, & Weller, 2020; Qiu, Chiu, Zhao, Sun, & Chen, 2021). All these elements are valid for both AR and VR, but they are especially pertinent in the case of VR environments. Based on the discussed literature, and other several studies (Hrib, 2020; Osadci-Baciu & Zbuchea, 2024; Osadci-Baciu, Zbuchea, Pînzaru, 2024), Table 1 exhibits the virtues and cons related to various book formats: physical books, e-books, audiobooks, AR books, and VR books.

Table 1. Book formats analysis (Source: own representation)

Format	Pros	Cons
Physical Books	Sensory experience (tactile, smell, etc.) which increases relaxation and places the reader in a certain *reading mood*.	Some difficulties with transportation (difficult to transport a heavy book or multiple books).
	Better concentration due to no additional distractions or notifications.	Harder to search for a certain passage (compared with keyword search in electronic devices).
	No technology-related issues, such as running out of battery, frozen screens, or data loss.	The text size and font cannot be adjusted to better suit somebody's sight.
	Less strain on the eyes during longer reading sessions.	More difficult to find, as it may be unavailable in some physical locations.
	It has physical and aesthetic value, can be collected, displayed as a conversation starter, or given as a gift.	More susceptible to physical loss or damage over time.
	Possible to receive the author's autograph on it, further enhancing both its emotional and monetary value.	Appropriate light is necessary for reading.
	Offers a full reading experience in the classical way, which may lead to better engagement.	More difficult or not possible to read for people with certain disabilities (blindness, some neurodivergent conditions).
E-books	One can store and transport a large number of books within a single device of reduced dimensions.	Reading experience depends on the support device's battery life.
	The text font and dimensions, as well as the screen light, can be adjusted so it suits various tastes and needs.	Eye strain and screen fatigue are very common during long e-book reading sessions.
	Easier to find needed passages due to keyword search possibility.	There is a risk of losing one's personal library due to technical issues.
	Desired titles are easier to find by searching on the internet, and the delivery is instant.	In case an e-reader device is used, its initial cost may be high.
	Possibility to read in darker environments, no need for appropriate outside light.	Potential privacy concerns exist regarding reading and book

		buying/downloading habits being tracked.
	Can be enhanced with multimedia elements, dictionary/glossary, and links to resources.	Some book formats may not be compatible with all devices, or DRM issues might arise when trying to sync.
	Most of the time, this option has the lowest cost.	This might not be a suitable option for leisure reading, as the screen time detracts from the relaxing experience.
Audiobooks	Can be read (listened) by visually impaired people.	Staying focused may be more difficult for people who are more *visual* or have a more developed visual memory.
	Can be listened to while doing other activities (driving, walking, house chores, etc.).	The narrator's style and the accents they use when reading might not appeal to everybody or may even detract from the original meaning.
	May be useful for language and pronunciation learning.	It is more difficult to quote or cite certain passages (most often, a written counterpart should be found).
	Involves minimal eye strain.	Just like e-books, the listening experience depends on the device's battery life and sometimes on the headphones' battery life too.
	Can be listened to by multiple people at the same time.	Audiobooks might not be suitable for highly complex or academic reading materials, especially those that involve figures and require visual understanding.
	Can enhance the text's understanding through the engaging reading style of the narrator.	One cannot search by a keyword or phrase to find a passage; it's not very easy to skim through.
	By including music and sounds, these books may heighten the reader's emotional response.	Narration speed may be an issue (even if various speed options are available).
AR books	The addition of dynamic elements can enhance curiosity and learning.	AR books are dependent on specific technology and compatible devices to be used.
	It may be more engaging, especially for children, due to a higher level of interactivity.	Interactive elements may distract the reader from the core text.
	Successfully combines physical and digital experiences.	As their development cost is currently higher, so is the consumer cost.
	Can make complex concepts more accessible by	AR book format may not be suitable for all book genres and types.

	providing multiple layers of information.	
	Encourages active engagement with the content, making it very suitable for learning activities.	The AR books' enhancing elements may, in fact, detract from the imagination-driven immersiveness provided by classical books.
	Can be helpful for people with neurodivergent conditions and learning impairments.	Their use for extended periods of time can cause tiredness and possible eye strain.
VR books	Provide an immersive, cinematographic or video game-like experience.	Does not seem to be suitable for long *reading* sessions or entire books; more likely for complementary products such as teasers, book-related games, etc.
	Allow for 3D visualization and exploration of complex concepts, which make them suitable for educational content.	High development costs lead to high costs for users; quite expensive equipment is also required.
	There is potential for social reading experiences (similar to multi-user video games).	Some people may not feel comfortable in VR environments; even trauma can be caused by these powerful, lifelike experiences.
	Potential for the reader to be transported into the book's universe through a multisensory experience.	There is potential for technical issues or glitches that may severely impact the user experience.
	Potential for gamification of reading, which could lead to an increase in leisure reading's popularity.	Overly relying on such environments, especially for learning and reading, may detract from users' creativity and ability to imagine and visualize on their own.

Ultimately, AR and VR have a lot of potential in enhancing the user experience in cultural areas, including reading and book market (Verhulst, Woods, Whittaker, Bennett, & Dalton, 2021). Although VR can provide a much more immersive experience, it poses more challenges than AR. Applications such as Magic Book that use Augmented and Mixed Reality can be particularly helpful for people with learning disabilities, attention deficit or similar conditions (Flores-Gallegos, Rodríguez-Leis, & Fernández, 2022). They can improve the reading experience and help in comprehending the information. These applications can also be useful for marketing books as they can serve as book trailers to incentivize people to read, increase motivation and desire to read. While most of the current applications are around education and science (Hutchison, 2018), there are already some studies exploring their use in fiction reading.

Methodology

A bibliometric analysis was conducted to examine research trends in reading experience using AR and VR technologies. Bibliographic databases from two major sources, Web of Science and Scopus, were utilized to comprehend a wide range of relevant publications. A parallel search between the two databases has been conducted. The timeframe taken into account was the last 10 years, 2014-2024, as this appears to be the period in which more intense research in the area of AR and VR applications used in reading began.

- 1st search in Scopus: (TITLE-ABS-KEY ("reading") AND TITLE-ABS-KEY ("virtual reality")) – yielded 921 documents.
- 2nd search in Scopus: (TITLE-ABS-KEY ("reading") AND TITLE-ABS-KEY ("augmented reality")) – yielded 655 documents.
- 1st search in Web of Science: (TS=("reading")) AND TS=("virtual reality") – yielded 389 documents
- 2nd search in Web of Science: (TS=("reading")) AND TS=("augmented reality") – yielded 369 documents

The resulting datasets have been imported into a dedicated Zotero group where they have been combined into a unique RIS file, the duplicates have been merged, and the remaining documents have been reviewed for thematic accuracy. A final dataset with 1540 unique items resulted.

In VOSviewer, a keyword co-occurrence type of analysis was employed, using the full counting method. The minimum number of occurrences has been set as 15 for higher accuracy. To ensure consistency and keywords relevant to this analysis being displayed, a thesaurus file has been applied, and some keywords have been replaced with abbreviations for better visualization in the graphical network. Table 2 presents the terms from the thesaurus file.

Table 2. Thesaurus file (Source: own representation)

Label	Replace by
e-learning	learning systems
human-computer interaction	HCI
three-dimensional computer graphics	3D graphics
learning	learning systems
helmet-mounted displays	HMD
augmented reality technology	AR technology
artificial intelligence	AI

augmented reality applications	AR apps
user experience	UX
virtual reality technology	technology

Some of the words that were too general or related to research design only have been excluded from the analysis. They are displayed in Table 3.

Table 3. Excluded terms (Source: own representation)

Term	Exclusion criteria
virtual reality	excluded, search term
human	exclude, generic term
augmented reality	exclude, search term
article	exclude, generic term
female	exclude, research design related
humans	exclude, generic term
male	exclude, research design related
adult	exclude, research design related
controlled study	exclude, research design related
reading	exclude, search term
clinical article	exclude, generic term
priority journal	exclude, generic term
procedures	exclude, research design related
aged	exclude, research design related
middle aged	exclude, research design related
design	exclude, research design related

Finally, 24 keywords resulted, divided into three clusters. The respective information is analyzed in the upcoming section, “Findings and discussion”.

Results and discussion

The VOSviewer analysis yielded 3 clusters, as presented in Table 4. The number of links between the 24 resulting keywords is 181, indicating a high level of interconnection and suggesting the interdisciplinarity of the research in this field. The total link strength is 614, indicating that these items are frequently co-occurring and that interest in research at their intersection is quite strong. Looking at the whole landscape of this bibliometric network, it can be observed that the research regarding reading in augmented and virtual reality setups revolves around learning systems. It seems that the benefits and challenges related to AR and VR in a reading experience context are most researched in educational reading and learning materials.

Table 4. VOSviewer clusters
(Source: own representation based on VOSviewer output)

Red Cluster	Green Cluster	Blue Cluster
Application programs	3D graphics	Image processing
AR apps	AI	Immersive
AR technology	Behavioral research	VR technology
Computer-aided instruction	Eye tracking	
Education	HCI	
Educational technology	HMD	
Engineering education	Robotics	
Learning systems	User interfaces	
Reading comprehension	UX	
Students	Visualization	
Teaching		

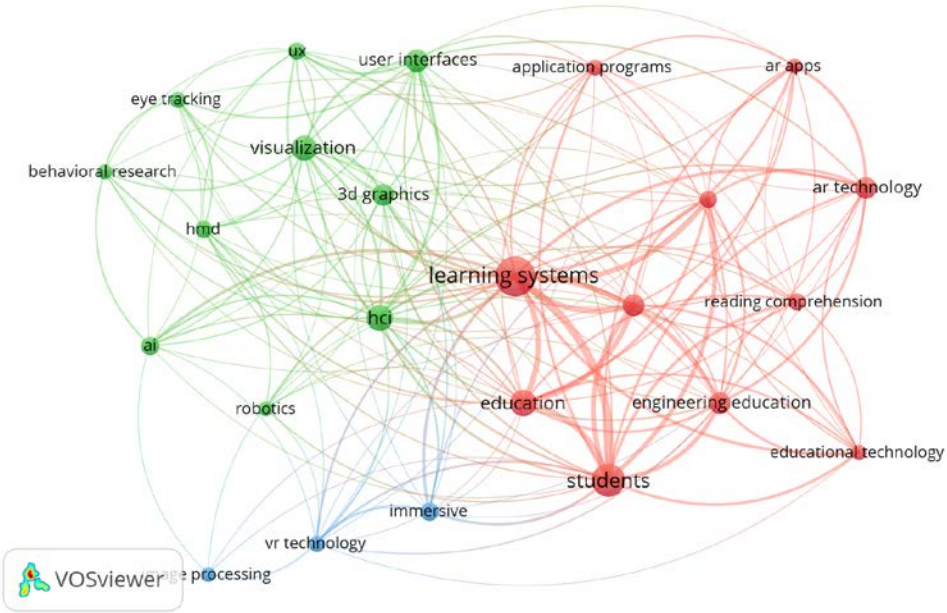

Figure 1. VOSviewer bibliometric network
(Source: VOSviewer output based on own research)

Narrowing the analysis at the cluster level, it seems that the red cluster, consisting of the highest number of items with the strongest nodes, is focused on AR reading applications in the educational setting, as indicated by keywords such as "education", "educational technology", "learning systems", "students", and "teaching". As reading is a particularly important aspect of academic activities and the learning process in general, it appears that the current *hot topic* at the intersection of "reading", "AR" and "VR" is enhancing current teaching methodologies as well as learning systems and applications. The presence of "computer-aided instruction" further points to a focus on how these technologies can be used as tools to enhance traditional teaching methods. Keywords "AR apps" and "AR technology" indicate that the research in this area is more focused on AR as a tool enhancing learning abilities than on VR, and, as another keyword in this cluster implies, AR may present a high potential in enhancing reading comprehension. This aligns with what the literature suggests that many of the AR applications for reading are developed in the educational area, as it often acts as a facilitator for learning, fostering curiosity and better retention of the read information (Danaei, Jamali, Mansourian, & Rastegarpour, 2020; Panchenko, Vakaliuk, & Vlasenko, 2020; Yilmaz, Kucuk, & Goktas, 2017). AR reading generally enriches the experience of reading non-fiction or learning materials by embedding relevant multimedia content, such as 3D models, videos, or interactive graphics. The presence of "engineering education" in this cluster may indicate that AR technology is more frequently used as an enhancement in the reading and learning activities in engineering as a field of study, but it may also imply that the future of AR capabilities and functionalities is related to the development of engineering education. Overall, the red cluster suggests significant potential for VR, especially AR, in learning environments, which is particularly important for students with conditions such as dyslexia or other reading impairments in traditional settings.

The green cluster focuses on the technical aspects of improving the user experience when reading in AR and VR environments. This is emphasized by the presence of keywords such as "UX" (user experience), "user interfaces", "HMD" (Head-Mounted Display), "HCI" (human-computer interaction), as well as "AI" and "robotics" that point even more towards potentially developing new capabilities that allow for more immersiveness or adjustable immersiveness, more intuitive interfaces, creating more intelligent virtual environments, or improving overall system performance. The keyword "visualization" is quite central to this cluster, speaking to how important the visual component is in these types of technologies, given its strong link to the "3D graphics" keyword, a fundamental component in creating realistic and high-quality virtual environments. Finally, the "eye tracking" and "behavioral research" keywords point towards current research around better understanding user behavior in AR and VR environments. The *eye-tracking method* is used for the device to *understand* how to adjust the virtual environment in such a way that the user can clearly see the desired information, in this particular case also the way they read the written text in AR or VR environments. At the same time, cognitive reactions and perceptions can be tracked using eye tracking methods. These elements are particularly important in creating more intuitive and intelligent interfaces, as well as for user psychological safety.

The blue cluster, consisting of only three keywords, "VR technology", "image processing", and "immersive", points to the high level of immersiveness in VR environments, as suggested by the literature (Dooley, 2017; Kuzmičová, Mangen, Støle, & Begnum, 2017; Pianzola, Bálint, & Weller, 2020; Rooney, Burke, Balint, O'Leary, Parsons, Lee, & Mantei, 2017). The keywords in this cluster seem to have strong links to the "learning systems" node in the red cluster, which points to the fact that there might be research on immersive VR reading in educational and learning contexts. The "image processing" keyword suggests research in the improvement of quality and possible *intelligent* features of VR capacity for generating synthetic images. In the bibliometric network, its link to the "AI" keyword from the green cluster is quite visible, further supporting this point of current research in the area of visual information handling, the possibility of enhancements and customization through AI, and user experience of reading and learning in this kind of virtual environment.

A limitation related to the current analysis is that reading, while directly related to the book market and publishing, is a broader concept, so it might refer to reading in other contexts as well. However, all research related to reading in such alternative environments is important for the book market as it provides valuable insights into new ways of engaging readers, potentially opening up new markets for digital and interactive books of different genres with a focus, as the research suggests, on non-fiction and educational materials.

Several results from the discussed studies, which are also part of the above analysis, point to AR and VR technologies having the potential to increase engagement, motivation, immersion, and enjoyment when incorporated into reading experiences, compared to traditional print formats. To summarize some instances, the study by Cheng (2017) found that reading an augmented reality book led to higher levels of motivation and more positive attitudes compared to a traditional printed book, with students reporting feeling more satisfied and engaged when using the AR book. Following a similar pattern of thought, Danaei, Jamali, Mansourian, and Rastegarpour

(2020) study results point to the fact that children reading an AR storybook showed significantly better reading comprehension compared to those reading a print version, in terms of both retelling and recalling the story. This suggests that AR storybooks can support children's literacy learning, provided the digital content aligns with the storyline. On the VR research side, research by Schmidt, Ehrenbrink, Weiss, Voigt-Antons, Kojic, Johnston, and Moller (2018) showed that using a virtual reality environment congruent with the reading activity increased participants' motivation and engagement, by finding higher levels of intrinsic motivation and flow when the VR setting matched the content being read. A study on narratives and readers' empathy by Kuzmičová, Mangen, Støle, and Begnum (2017) suggested that experiencing a story in a VR environment that matches the story setting could intensify readers' emotional and spatial immersion in the narrative. Concludingly, these findings highlight the important potential of AR and VR technologies in educational settings, particularly in enhancing reading experiences, increasing motivation to read, and helping with literacy development.

Conclusions

Emerging technologies like augmented reality, virtual reality, and mixed reality are still in their infancy. While they have yet to penetrate the mass market in most industries, they have tremendous potential for the future. Multimodal devices, like their smart device predecessors, could eventually capture a significant market share across industry sectors. To prepare for this, it is important that companies adopt a forward-thinking strategy and consider how such applications could transform their business practices, products, and business models.

AR and VR technologies can offer a more interactive and engaging learning experience in educational settings, especially in practical subjects like biology, geography, and astronomy. Through simulations, users can gain a deeper understanding of how things work and retain information more effectively. Additionally, customized learning paths can be created within books, tailoring content to individual readers' preferences, learning styles, and comprehension levels. By providing alternative formats and sensory experiences, AR and VR can improve accessibility for readers with different learning preferences, disabilities, or language barriers, ultimately making education and literature more inclusive.

Leisure reading is not as heavily researched as educational reading, but it is a valuable area for further exploration. AR and VR technologies can be used to enhance storytelling techniques. For example, authors and publishers can work with technology companies to experiment with innovative ways of storytelling in AR and VR, incorporating dynamic elements, interactive plots, and immersive visuals to engage readers in new and exciting ways. Additionally, AR and VR environments can be used to organize book-related events that allow for participation beyond physical boundaries, making the experience more vivid and immersive than simple online events.

There are several challenges to consider when incorporating multimodal layers and extended reality into the publishing industry. One significant issue is the high implementation costs involved. Since publishing companies typically have limited knowledge in this area, partnering up with technology companies or hiring external

consultants may be necessary. Another challenge is the lack of standardized AR/VR content, including text sizes and fonts, which can make implementation even more difficult. Privacy concerns are also significant to consider, as there is already a trade-off between personalized experiences and user privacy with smart devices. Additionally, some readers may face challenges adapting to new modes of reading, including issues related to motion sickness or discomfort in VR environments or simply a reluctance to integrate technology into the reading process. High costs for users may also be a barrier to adoption. The diverse range of AR and VR devices and platforms may also lead to market fragmentation, making distribution more challenging and complicating publishers' ability to reach a broad audience.

As technology continues connecting the world, companies in the book sector should take into account the potential of AR and VR technologies and find ways to use them to improve their offerings and create a more immersive and engaging experience for readers. The benefits of these technologies go beyond the book market and could be useful for industries such as education, technology, and even medicine. Additionally, policymakers could explore the AR and VR applications for reading to coordinate, finance, and sustain possible applications and training in the education industry, especially for individuals with learning difficulties. The interdisciplinary nature of this topic allows for research across multiple industries, as well as opportunities for new partnerships and collaborations.

References

Aukstakalnis, S. (2016). *Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability).* Addison-Wesley Professional.

Bloome, D. (1985). Reading as a Social Process. *Language Arts, 62*(2), 134-142. https://www.jstor.org/stable/41405591

Bira, M., Zbuchea, A., & Romanelli, M. (2020). Romanian Museums under Scrutiny. *Management Dynamics in the Knowledge Economy, 8*(3), 297-323. https://doi.org/10.2478/mdke-2020-0019

BrainSTEAM Education. (n.d.). *AR Books*. Retrieved September 30, 2024, from https://brainsteamedu.com/collections/ar-books?srsltid=AfmBOorvThFeuuOj-w99MrTgsjLI3VaSloEDbQ2zw31he_pXsDBYGL0E&_sm_nck=1

Cheng, K.-H. (2017). Reading an augmented reality book: An exploration of learners' cognitive load, motivation, and attitudes. *Australasian Journal of Educational Technology, 33*(4), 53-69. https://doi.org/10.14742/ajet.2820

Cline, E. (2011). *Ready Player One*. Random House.

Cranmer, E. E., tom Dieck, M. C., & Fountoulaki, P. (2020). Exploring the value of augmented reality for tourism. *Tourism Management Perspectives, 35*, 100672. https://doi.org/10.1016/j.tmp.2020.100672

Danaei, D., Jamali, H. R., Mansourian, Y., & Rastegarpour, H. (2020). Comparing reading comprehension between children reading augmented reality and print storybooks. *Computers & Education, 153*, 103900. https://doi.org/10.1016/j.compedu.2020.103900

Dooley, K. (2017) Storytelling with virtual reality in 360-degrees: a new screen grammar. *Studies in Australasian Cinema, 11*(3), 161-171. https://doi.org/10.1080/17503175.2017.1387357

Döring, U., Müller, B., Rohr, S., Ruhrmann, J., & Schäfer, M. (2022). Listen and Read: The Battle for Attention: A New Report About Key Audience Behaviour in the Age of eBooks, Audiobooks and Podcasts. *Publishing Research Quarterly, 38*, 40-52. https://doi.org/10.1007/s12109-021-09853-2

Farshid, M., Paschen, J., Eriksson, T., & Kietzmann, J. (2018). Go boldly!: Explore augmented reality (AR), virtual reality (VR), and mixed reality (MR) for business. *Business Horizons, 61*(5), 657-663. https://doi.org/10.1016/j.bushor.2018.05.009
Flores-Gallegos, R., Rodríguez-Leis, P., & Fernández, T. (2022). Effects of a virtual reality training program on visual attention and motor performance in children with reading learning disability. *International Journal of Child-Computer Interaction, 32*, 100394. https://doi.org/10.1016/j.ijcci.2021.100394

Galor, O. (2022). *The Journey of Humanity: The Origins of Wealth and Inequality*. Dutton. 10.1111/padr.12566

Horowitz-Kraus, T., & Hutton, J. S. (2018). Brain connectivity in children is increased by the time they spend reading books and decreased by the length of exposure to screen-based media. *Acta Paediatrica, 107*(4), 685-693. https://doi.org/10.1111/apa.14176

Hrib, B. (2020). Books in Time of Pandemia: Romania, One Way Again – From Paper to Internet? In R. Pamfilie, V. Dinu, L. Tăchiciu, D. Pleșea, & C. Vasiliu (Eds.), *Proceedings of the 6th BASIQ International Conference on New Trends in Sustainable Business and Consumption* (pp. 1042-1048). ASE.

Hung, S. C., & Tu, M. F. (2011). Technological change as chaotic process. *R&D Management, 41*(4), 378-392. https://doi.org/10.1111/j.1467-9310.2011.00641.x
Hutchison, A. (2018). Using Virtual Reality to Explore Science and Literacy Concepts. *The Reading Teacher, 3*, 343-353. https://doi.org/10.1002/trtr.1720

Johnson, B. K., & Rosenbaum, J. E. (2015). Spoiler Alert: Consequences of Narrative Spoilers for Dimensions of Enjoyment, Appreciation, and Transportation. *Communication Research, 42*(8), 1068–1088. https://doi.org/10.1177/0093650214564051

Kojic, T., Ali, D., Greinacher, R., Möller, S., & Voigt-Antons, J.N. (2020). User Experience of Reading in Virtual Reality - Finding Values for Text Distance, Size and Contrast. In *2020 Twelfth International Conference on Quality of Multimedia Experience (QoMEX)*, (pp. 1-6). https://doi.org/10.1109/QoMEX48832.2020.9123091

Kuzmičová, A., Mangen, A., Støle, H., & Begnum, A. C. (2017). Literature and readers' empathy: A qualitative text manipulation study. *Language and Literature, 26*(2), 137–152. https://doi.org/10.1177/0963947017704729

Louvre. (2021, October 22). *The Mona Lisa in virtual reality in your own home*. https://www.louvre.fr/en/explore/life-at-the-museum/the-mona-lisa-in-virtual-reality-in-your-own-home

Marshall, C. (2023, November 30). *Rome Reborn: A new 3D virtual model lets you fly over the great monuments of ancient Rome*. Open Culture. https://www.openculture.com/2023/11/rome-reborn-a-new-3d-virtual-model-lets-you-time-travel.html

Magic Keys. (n.d.). *Magic Keys - Learn piano in VR*. https://magickeys.app/
Osadci-Baciu, A., & Zbuchea, A. (2024). The Economics of Publishing: A Bibliometric Research Landscape. *The USV Annals Of Economics And Public Administration, 24*(1(39)). Retrieved October 11, 2024, from http://www.annals.seap.usv.ro/index.php/annals/article/view/1512

Osadci-Baciu, A. M., Zbuchea, A., & Pînzaru, F. (2024). Exploring the Impact of Digital Platforms on Publishing: A Bibliometric Analysis. *Proceedings of the International Conference on Business Excellence, 18*(1), 3684-3698. https://doi.org/10.2478/picbe-2024-0299

Özkul, E., & Kumlu, S. T. (2019). Augmented Reality Applications in Tourism. *International Journal of Contemporary Tourism Research, 3*(2), 107-122. https://doi.org/10.30625/ijctr.625192

Panchenko, L. F., Vakaliuk, T. A., & Vlasenko, K. V. (2020). Augmented reality books: concepts, typology, tools. In O. Yu. Burov, & A. E. Kiv (Eds.). *Proceedings of the 3rd International Workshop on Augmented Reality in Education* (pp. 283-296). doi:10.31812/123456789/4414

Peltoniemi, M. (2015). Cultural Industries: Product–Market Characteristics, Management Challenges and Industry Dynamics. *International Journal of Management Reviews, 17*, 41–68. doi 10.1111/ijmr.12036

Pianzola, F., Bálint, K., & Weller, J. (2020). Virtual reality as a tool for promoting reading via enhanced narrative absorption and empathy. *Scientific Study of Literature, 9*(2), 163 - 194. https://doi.org/10.1075/ssol.19013.pia

Qiu, X. yue, Chiu, C. K., Zhao, L. L., Sun, C. F., & Chen, S. jie. (2021). Trends in VR/AR technology-supporting language learning from 2008 to 2019: a research perspective. *Interactive Learning Environments, 31*(4), 2090–2113. https://doi.org/10.1080/10494820.2021.1874999

Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. *Computers & Education, 147*, 103778. https://doi.org/10.1016/j.compedu.2019.103778

Rauschnabel, P. A. (2021). Augmented reality is eating the real-world! The substitution of physical products by holograms. *International Journal of Information Management, 57*, 102279. https://doi.org/10.1016/j.ijinfomgt.2020.102279

Reality Remake. (2023, October 15). *An amazing VR piano learning game on the Oculus Quest 3 and 2: PianoVision review*. https://www.realityremake.com/articles/an-amazing-vr-piano-learning-game-on-the-oculus-quest-3-and-2-pianovision-review

Romano, A. (2024, August 6). *These 15 famous museums offer virtual tours you can take from your couch. Travel + Leisure*. https://www.travelandleisure.com/attractions/museums-galleries/museums-with-virtual-tours

Rooney, B., Burke, C., Balint, K., O'Leary, T., Parsons, T., Lee, C. T., & Mantei, C. (2017). Virtual reality, presence and social cognition: The effect of eye-gaze and narrativity on character engagement. In *23rd International Conference on Virtual System & Multimedia (VSMM)* (pp. 1–6). https://doi.org/10.1109/VSMM.2017.8346272
Schmidt, S., Ehrenbrink, P., Weiss, B., Voigt-Antons, J.-N., Kojic, T., Johnston, A., & Moller, S. (2018). Impact of Virtual Environments on Motivation and Engagement During Exergames. *2018 Tenth International Conference on Quality of Multimedia Experience (QoMEX),* 1–6. https://doi.org/10.1109/QoMEX.2018.8463389

Stephenson, N. (1992). *Snow Crash*. Bantam Books.

Stephenson, N. (1995). *The Diamond Age: Or, A Young Lady's Illustrated Primer*. Bantam Books.

Stories AR. (n.d.). *Top 5 best-selling augmented reality books.* Retrieved September 30, 2024, from https://stories-ar.com/eng/top-5-best-selling-augmented-reality-books

Sumardani, D., & Lin, C. J. (2023). Cognitive processes during virtual reality learning compared to traditional reading: An experimental study. *Computers & Education, 196*, 104745. https://doi.org/10.1016/j.compedu.2023.104745

Taleb, N. N. (2012). *Antifragile: Things that Gain from Disorder*. Random House.

Troscianko, E. T., Carney, J., Mavrogianni, A., & Kucirkova, N. (2021). Comparing a printed book and a VR reading environment: Effects on narrative absorption, empathy with fictional characters, and intention to continue reading. *Discourse Processes, 58*(9), 819-842. https://doi.org/10.1080/0163853X.2021.1947313

Verhulst, I., Woods, A., Whittaker, L., Bennett, J., & Dalton, P. (2021). Do VR and AR versions of an immersive cultural experience engender different user experiences?. *Computers in Human Behavior, 125*, 106951. https://doi.org/10.1016/j.chb.2021.106951

Vinge, V. (2006). *Rainbows End*. Tor Books.

Yilmaz, R. M., Kucuk, S., & Goktas, Y. (2017). Are augmented reality picture books magic or real for preschool children aged five to six?. *British Journal of Educational Technology, 48*(3), 824-841. https://doi.org/10.1111/bjet.12452

Zbuchea, A., Bira, M., & Balan, E. A. (2025). Enhancing Engagement With Museums Through Phygital Marketing Strategies. In K. Djakeli (Ed.), *Phygital Approaches to Social Marketing* (pp. 127-154). IGI Global. https://doi.org/10.4018/979-8-3693-3924-4.ch007