Exploring Instructional Designers' Perceptions of Using Augmented Reality

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Abstract

The purpose of this qualitative hermeneutic phenomenological study is to explore instructional designers' perceptions of why they are not using augmented reality (AR) as part of their course development practice, addressing a notable gap in the literature that primarily focuses on teachers' experiences. Recognizing AR's potential as a transformative educational tool, the research examines the limited understanding of instructional designers' perspectives. With rapid advancements in mobile and AR technologies, this current study is crucial for understanding why instructional designers may hesitate to incorporate AR into curricula, ultimately impacting educational quality. In this qualitative study, seven instructional designers with at least three years of experience participated in individual interviews and an online focus group. Data analysis using NVivo software revealed two primary themes: perceptions of AR's benefits and barriers to its implementation. Although designers acknowledged AR's ability to enhance student engagement and learning, they encountered challenges such as device usability, limited knowledge of AR technology, logistical issues, financial constraints, and insufficient training time. The findings highlight the need for professional development and institutional support to encourage AR integration. The study concludes with practical implications, including the need for targeted professional development, collaborative AR content creation, technological infrastructure investment, and comprehensive instructional design training programs. Additionally, it recommends future research on AR's impact on student outcomes and practical instructional design frameworks. By addressing these barriers and harnessing enthusiasm for AR, educational institutions can better prepare for its transformative potential in learning environments.

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Chapter 1: Introduction

Due to significant interest in incorporating new technological learning methodologies and the rapid evolution of mobile technology, there has been an increase in studies surrounding the use of augmented reality (AR) in various fields (Chen et al., 2020; Hantono et al., 2018; Tuli et al., 2021). Researchers have completed AR studies in teaching, training, learning, and use in the corporate world. Most of the studies are in science and social science education (Hantono et al., 2018; Kuru & Zeybek, 2021; Sahin & Yilmaz, 2020). Augmented reality studies in the corporate world are found in construction, interior design, tourism, and marketing, to name a few (Andini et al., 2020; Chang et al., 2020d; Heejun & Chang-Hoan, 2019; Kim & Irizarry, 2021). Gallego (2020) stated that "Augmented reality (AR) applications have gained popularity, especially when smartphones gained capable camera sensors, gyroscope, and other sensors" (p. 111).

Augmented reality is an interactive learning environment where software overlays digital objects in a physical, real-world environment (Acikgul & Firat, 2021; Le et al., 2021; Lim et al., 2020). Interaction with digital objects based on sensory inputs, such as graphics, sound, video, or device location (GPS), triggers software events (Dirin, 2020; Majid & Salam, 2021). Smartphones and head-mounted displays exhibit virtual objects in a natural environment (Fransson et al., 2020). However, instructors do not commonly use head-mounted displays because of the associated challenges. For example, Fransson et al. (2020) stated that some head-mounted display applications cause cognitive overload and dizziness. Other challenges relate to costs, hardware, and content. The larger the project, the more it will cost to develop, maintain, and provide enough hardware processing power (Barroso-Osuna et al., 2019; Huang, 2021). Fransson et al. (2020) also discussed that most applications designed for head-mounted displays are for entertainment purposes, not education. In addition to developing expensive, unique applications, managing software updates would be problematic. Updating software would be problematic due to the different hardware configurations since no industry-wide standard exists (Barroso-Osuna et al., 2019).

Developing AR applications requires that an instructional designer have software programming skills or hire a developer. A developer can use various software development tools to build AR applications, which vary in complexity to meet the developer's proficiency in programming and authoring tools (Dirin, 2020). The cost of the tools can vary from free to monthly or yearly usage fees. Augmented reality development tools include AR-Media, ARKit, ARToolKit, MRToolKit, ARToolWorks, PlugXR, Layar, Vuforia, Wikitude, and ARCore (Chang et al., 2020c, d; Gallego, 2020; Le et al., 2021; Parmaxi & Demetriou, 2020; Pathania et al., 2021). Many other available tools are not listed, which does not account for unknown tools. Due to the fluidity of technology, some of these development tools may become obsolete or not supported. An example of a tool no longer supported is HP Reveal (a.k.a. Aurasma) (Barroso-Osuna et al., 2019; Parmaxi & Demetriou, 2020). With the recent advancements in development tools, AR applications can now be developed graphically with tools like Blippar, Layar, Wikitude, and others without the user requiring programming skills (Karacan & Akoglu, 2021; Parmaxi & Demetriou, 2020).

Most educational applications developed for studies included games in an academic context (Hantono et al., 2018; Tuli et al., 2021). Some games consisted of students scoring points, while others allowed them to role-play, thus enhancing their direct experience and interaction (Pellas et al., 2019; Saleem et al., 2022). There was also an increase in studies promoting the effectiveness of AR. For example, Hantono et al. (2018) and Karthik et al. (2019)

found that face-to-face learning is ineffective compared to AR learning. In a meta-analysis by Tuli et al. (2021), the authors found the results of many studies showing AR to be interactive and permitted collaborative learning without meeting others in person. With these advantages, face-to-face learning has a complementary role, but textbooks are still considered a primary tool for introducing new topics (El Kouzi et al., 2019; Pathania et al., 2021).

According to researchers, AR can be helpful at every level of education due to its many benefits and malleability (da Silva et al., 2019; Hantono et al., 2018). Sarigoz (2019) stated that educational AR frequently uses text augmentation, symbols, indicators, videos, pictures, 3D models, and animations. Of all the interactive options, El Kouzi (2019) and Hantono et al. (2018) found that 3D models contribute to more effective and permanent learning. These interactive options encouraged the students to explore and interact with AR models, games, and virtual objects (Chang et al., 2020d; Hantono et al., 2018; Saleem et al., 2022). Students using AR could explore and experiment with dangerous situations without exposure to actual harm and visually grasp abstract concepts.

Aside from all the advantages of AR, there are many challenges to overcome when implementing an AR system. Akçayır and Akçayır (2017) found that using an AR system was the most reported challenge experienced by students. A poorly designed user interface (UI) affects educational effectiveness. Additionally, teachers reported a lack of appropriate Information and Communication Technology infrastructure (Alkhattabi, 2017; Barroso-Osuna et al., 2019). Designers must address usability issues because AR requires extensive interaction. Students lose time completing assignments with a poorly designed UI. Akçayır and Akçayır (2017) suggested that other challenges in designing AR systems are the students' cognitive overload that they may experience due to the amount of material presented and the complexity of the tasks. Lim et al. (2020) found quite the opposite; the authors found that AR in a real-world environment reduced the learners' cognitive overload when using well-designed scaffolding. Steele et al. (2020) stated a lack of ethical considerations in systems design. Another challenge stated by Sánchez et al. (2019) was the willingness of the instructors to adopt AR.

Instructional designers have training in creating learning experiences that are efficient and effective (Karthik et al., 2019). They systematically develop instructions that ensure quality learning. Klein and Kelly (2018) stated that one of the competencies of instructional designers includes applying "…knowledge of learning theories and principles" (p. 232). Karthik et al. (2019) discussed how instructional designers draw their strategies from various disciplines, such as behavioral and educational psychology and systems theories, to name a few.

Smith (2011) stated that instructional designers are leaders in professional learning communities and transformative change and are vital to a professional learning community looking to transform its instructional training. "In order to sustain the transformative change, a sustainable source of fresh ideas and perspectives is needed" (Smith, 2011, p.2). Instructional designers derive their ideas and develop their creativity as they work with clients to understand their needs and objectives and work with various team members from different fields. In addition, instructional designers improve their technology literacies through technology training (Xie & Rice, 2021). With access to new ideas and technology, instructional designers are ideal candidates for developing new products, including AR.

Despite the benefits and educational applications available through AR, Oliveira da Silva et al. (2019) discovered through their research that AR use is limited in education. The authors' study results manifested a lack of infrastructure and authoring tools as the two most significant contributors to classroom AR usage hindrances. Mystakidis et al. (2021) found that AR-supported instruction had recently gained momentum; Martlı and Ünlüsoy Dinçer (2021) itemized a list of AR usage in various industries, e.g., military, advertisement, art, marketing, and other fields reinforcing Aslan et al. (2019) examples of the use of AR in these various industries. Martlı and Ünlüsoy Dinçer (2021) also stated that apart from AR's benefits, the disadvantages associated with its use limit its acceptance. Kljun et al. (2020) stated that there is no official data on the use of AR by schools, educators, or institutions. By obtaining the number of downloads of AR-based educational applications from Google Play and the Apple App Store, the authors speculated that they could infer the amount of usage in education. Patterson and Han (2019) discussed a critical barrier to developing course content using emerging technology: finding meaningful professional development to support their lesson plans. Instructional designers are the catalysts for transformational change (Smith, 2011); however, no studies show how instructional designers lead the change in AR. Therefore, to fill this lacuna, there needs to be a study on the barriers impeding instructional designers from implementing AR into their training courses. Alkhattabi (2017) mentioned how teachers are resilient to change, and most lack IT skills; understandably, they would not implement AR in their classes. However, instructional designers should welcome change and have IT skills to propel AR into various industries (Smith, 2011; Xie & Rice, 2021).

A meta-analysis study by Tezer et al. (2019) shows that researchers have conducted many studies on AR and its use in different educational environments. Their research results show that AR provides an effective and efficient learning environment. It is applicable across all academic levels and in many fields, such as Educational Technologies, Engineering Science, Mobile Applications, and Visual Arts Education. Tezer et al. (2019) point out that AR does not have to be limited to just education. They emphasize that "the integration of augmented reality applications in different areas such as 'Underwater Life Education,' 'Theater,' 'Elderly Care,' 'Ballet Training,' 'Scientific Literacy' and 'Online Shopping' have also been encountered" (p. 164).

As of this writing, the current selection of preferred AR development tools has not changed since studies by Al-Ansi et al. (2023), Lampropoulos et al. (2022a), Kamińska et al. (2023), and Syed et al. (2022). The tools presented in the aforementioned studies are helpful for different levels of programming skills and authoring content and for creating learning material tailored to individual differences in learning (da Silva et al., 2019). Despite all the studies on the benefits of AR, the focus of the studies centers on AR's potential uses and plausible benefits. According to Iqbal et al. (2022), researchers must move on from the research of AR and into researching the application of AR in education. It would benefit researchers to understand what impedes instructional designers from using AR and help find solutions that will propel the development of AR applications. Mundy et al. (2019) researched the teachers' perceptions of the effects of AR in the classroom. As researchers, we would also like to explore instructional designers' perceptions of AR and examine its acceptance level and willingness to use it to help identify the factors that influence the adoption and integration of AR in educational settings. In a research article by Kazanidis et al. (2021), the authors discussed how, by exploring instructional designers' perceptions, we can gain insights into how AR can enhance teaching and learning experiences and identify challenges and barriers to using AR in education.

Statement of the Problem

The problem addressed in this qualitative hermeneutic phenomenological study was the limited understanding of why instructional designers are not using augmented reality as part of their course development practice. Various authors have stated that AR is a rapidly developing innovative technology gradually gaining momentum (Afnan et al., 2021; Brown et al., 2020; Buchner et al., 2021; Maas et al., 2020; Mystakidis et al., 2020; Pathania et al., 2021; Sirohi et al., 2020; Tuli et al., 2021; Wei et al., 2021). Other authors have stated that various industries have adopted and integrated AR into their training (Huang et al., 2021; Pinar Martlı & Ünlüsoy Dinçer, 2021). Furthermore, according to Garzón (2021), there has been exponential growth in AR research. A considerable amount of research has focused on AR usage in education. However, there is scant literature on the needed requirements for designing AR instructional material (Brij & Belhadaoui, 2021; Sarkar & Pillai, 2021), and there is little literature on instructional designers' usage of AR.

Purpose of the Study

The purpose of this qualitative hermeneutic phenomenological study was to explore instructional designers' perceptions regarding the factors influencing their reluctance to incorporate AR into course designs. Through this study, I uncovered how instructional designers perceived using AR as a matter of practice. Additional information obtained from the study helped understand instructional designers' comfort levels and hindrances in using AR. The findings of my study explained why some instructional designers were reluctant to implement AR into their course curricula.

All participants in my study provided familiarity with and current use of AR through online structured forms. The information the participants provided gave me a baseline of their AR experience for the study. The study consisted of two sections: an online focus group and in-depth individual interviews (IDIs). Both methods allowed discussions in the interviews specifically centered on the factors that deter instructional designers from adopting AR and their perceptions of its potential benefits and drawbacks. The information obtained from the interviews formed the crux of the study. The findings from the study were categorized and sorted using the qualitative data analysis software NVivo.

The reason for using an IDI and a focus group was triangulation. Azad et al. (2021) described the IDI interview as the gold standard for understanding human beings and topics of limited knowledge. Santos et al. (2020) and Azad et al. (2021) described IDIs as flexible, allowing individual responsiveness. In the study by Santos et al. (2020), the authors described IDI interviews as a method for allowing spontaneity. In contrast to IDIs, focus groups provide the researcher with data from participants who interactively interchange comments. According to Gill and Baillie (2018), participants in a focus group can contribute different perspectives on the same topic to the research.

For my study, I had seven instructional designers with at least three years of experience working in the field participate in the IDI interview. Selecting experienced participants helped ensure the homogeneity of the group. I solicited the participation of instructional designers through a professional organization with a home base in Texas. The instructional designers from the IDI group had the opportunity to participate in a focus group to answer questions in a moderated setting. Guest et al. (2017) recommended having more than one focus group. Still, due to limited resource constraints, there was only one focus group session.

Introduction to Conceptual Framework

The COVID-19 pandemic became a global concern, leading many countries to institute nationwide lockdowns and social distancing among their citizens (World Health Organisation, 2020). The pandemic created an educational disruption affecting approximately 94% of the global student population (OECD, 2020; UN Sustainable Development Group, 2020). Teachers and management at all school levels now had the challenge of changing all aspects of teaching overnight. The need arose to reevaluate teaching, learning, assessment, research, service, and engagement (Eldokhny & Drwish, 2021; Sangster et al., 2020) and incorporate them into online learning. The emergency transition to distance learning became a treatment rather than a planned logistical response.

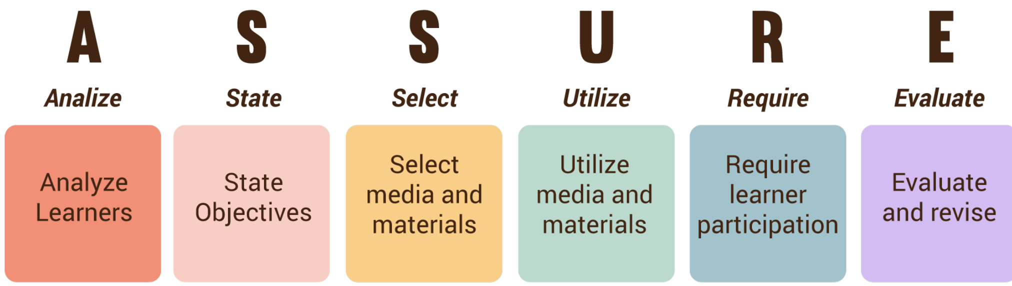
Many educational institutions struggled to transition to online education due to a lack of training, resources, and buy-ins from students and staff (Khan et al., 2021). Most importantly, a commonality stood out in Sangster et al.'s (2020) list of issues encountered during the transition to online education: the lack of instructional design. Because of the sudden transition to online education, no well-defined conceptual model guided instructors in developing AR components or courses that have become critical due to the pandemic (Eldokhny & Drwish, 2021; Sarkar & Pillai, 2021).

The three conceptual frameworks that underpinned my study and which are relevant for instructional designers in their AR coursework are the ASSURE model (Heinich et al., 1982), the TPACK framework (Mishra & Koehler, 2006), and the Kirkpatrick model (Kirkpatrick, 1994). These models are used in instructional design to guide the development and evaluation of learning experiences (Alsalamah & Callinan, 2021; Kholid et al., 2023; Stefaniak & Xu, 2020). By understanding and applying these models, instructional designers can ensure that AR-integrated learning experiences are effective, engaging, and aligned with learner needs (Gopalan et al., 2023; tom Dieck et al., 2024).

Heinrich and Molenda developed the ASSURE model in 1982. Grounded in constructivism, the instructional design model, integrates multimedia and technology into learning environments (Batır & Sadi, 2021). The fourth phase of the ASSURE model (select media and materials) is crucial for applying digital technology to the educational process. The ASSURE model is named after its six phases, as illustrated in Figure 1.

Figure 1

ASSURE Model.

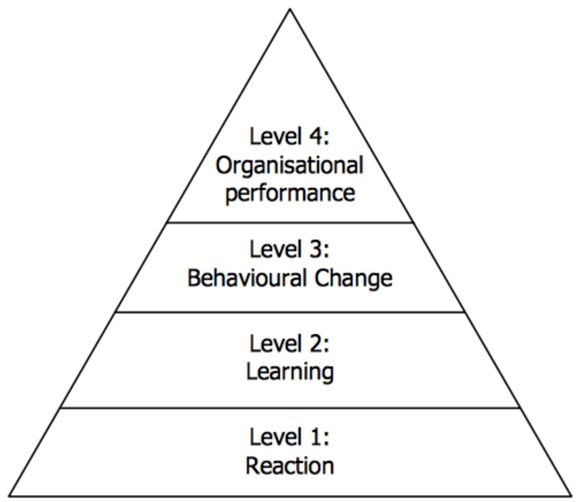


Note. From Caballero, A. (2021, May 12). *EXD Model: an instructional Design model for eLearning*. eLearning Industry. https://elearningindustry.com/exd-model-instructional-design-for-elearning

The Kirkpatrick model (See Figure 2) is a well-known framework for analyzing and evaluating the results of training programs (Kirkpatrick, 1996). The Kirkpatrick model consists of four distinct levels of evaluation: Level 1, Reaction, which assesses participants' immediate responses to the training; Level 2, Learning, which measures the extent to which participants acquire the intended knowledge, skills, and attitudes; Level 3, Behavior, which evaluates the transfer of that learning to the workplace and the impact it has on job performance; and Level 4, Results, which examines the ultimate outcomes of the training (Alsalamah & Callinan, 2021; Kirkpatrick, 1996).

Figure 2

Kirkpatrick Model.

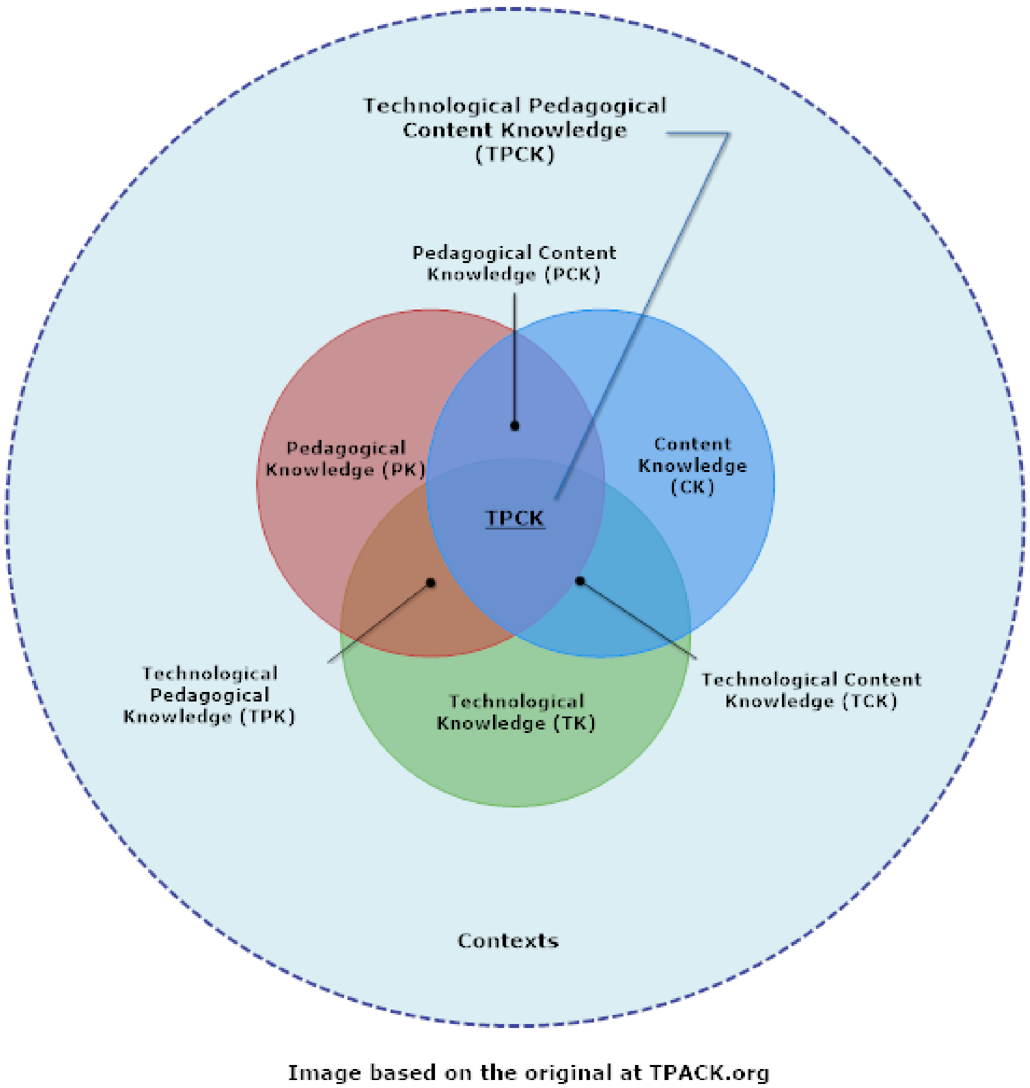


Note. From Kirkpatrick, D. (1996). Revisiting Kirkpatrick's four-level-model. *Training & Development, 50*(1), 54-59.

The TPACK model identifies three types of knowledge—technological, pedagogical, and content—required by instructors to effectively integrate technology into their instruction. .Acknowledging this knowledge's complex, multifaceted, and situated nature is crucial to the model. (Lavrysh, 2019; Mkoehler, 2017). The TPACK model is named after its three domains, followed by the word "knowledge," as shown in Figure 3.

Figure 3

TPACK Model



Note. Reproduced by permission of the publisher, © 2012 by tpack.org (Mkoehler, 2017).

By focusing on the "how" and "what" of AR lessons, the TPCK model guides instructional designers to meticulously outline all aspects of pedagogy, content, technology, and their interconnections. A detailed approach should address questions such as: How should the content be taught? What specific content should be delivered? What technological tools and resources are most suitable for the learning objectives?

Contrary to the TPCK model, phase four of the ASSURE model seeks to answer "which" questions. Questions such as which media should be used in the lesson? Which materials complement this lesson? Which materials can provide clear instructions and guidance? Which materials promote learner participation? Which materials match the curriculum?

With the existence of these frameworks, instructional designers would have had readily available knowledge in incorporating technology in online instructions during the COVID-19 pandemic. Instructional designers may have used the ASSURE model to develop multimedia instruction through videos, PowerPoint presentations, and audio files, but AR appears latent in incorporation. Could it be that instructional designers are unaware of the TPCK model? Or do instructional designers have other reasons for not incorporating AR into curricula? These questions were the basis for the development of this study.

Introduction to Research Methodology and Design

The purpose of this qualitative hermeneutic phenomenological study was to explore instructional designers' perceptions regarding the factors influencing their reluctance to incorporate AR into course designs. For this study, I used a qualitative method with a hermeneutic phenomenological design to investigate instructional designers' perceptions and acceptance levels regarding AR. The same method was applied to determine the instructional designers' willingness to use AR. In addition, this method helped to seek out any barriers that prevented instructional designers from implementing AR into course curricula.

Phenomenological studies allow for a combination of different data-gathering methods to understand the perceptions of the participants' motivations or choices. Data-gathering methods include interviews, reading documents, and watching videos (Bloomberg & Volpe, 2019). My study incorporated online structured forms to gather brief demographic profile information, familiarity, and current use of AR from all participants. In the online focus group, the participants discussed AR factors that instructional designers deem essential to learning and the impediments that prevented instructional designers from using AR.

Several studies have focused on integrating AR into education and its positive effects on learning. However, no studies showed what instructional designers perceived as essential to learning when using AR or what barriers prevented them from implementing AR into their courses. Although, there was a study that discussed why schools were not using AR from a teacher's perspective (Oliveira da Silva et al., 2019).

A training industry report by Freifeld (2019) stated that "the most frequently anticipated purchases are online learning tools and systems (44 percent vs. 41 percent last year)" (p. 21). The same indicated that planned anticipated augmented/virtual reality technology purchases were 15 percent. In addition, the aforementioned report showed that in training delivery, "some 23 percent of large companies currently are using virtual reality [and] 11 percent are using augmented reality" (p. 27). Small and midsize companies were using 5 percent or less of these technologies. It also showed that organizations have not rapidly adopted AR or virtual reality technologies. However, it failed to mention why organizations are slow to adopt augmented/virtual reality.

Research Questions

The two research questions of interest in this study were:

RQ1

What are the perceptions and experiences of instructional designers in incorporating AR into course designs?

RQ2

What barriers, if any, have instructional designers experienced in working with AR?

Significance of the Study

My study on instructional designers not creating AR-based instructional material was essential for providing insight into the underlying factors contributing to instructional designers' reluctance to adopt AR technology. It gave a fundamental understanding of instructional designers' perspectives regarding the use of AR and its role in learning (Kim et al., 2022). Kim et al. (2022) found that instructors perceive capacity and subject-matter knowledge-building as ideal learning goals best administered through interdisciplinary learning, authentic problem-solving, and creative tasks when coupled with student AI collaboration. They discussed AI knowledge-building and learning goals, which are also doable with AR technology. My study's results provided insight into instructional designers' barriers to creating AR-based course curricula (Barroso-Osuna et al., 2019; Patterson & Han, 2019; Sánchez et al., 2019).

Common researchers indicated a gap in implementing AR (Han et al., 2022; Karthik et al., 2019; Parmaxi & Demetriou, 2020). My study partially filled that research gap. The study results provided insight into creating new models similar to the combined ASSURE and TPCK models (Barroso-Osuna et al., 2019; Javaid et al., 2021; Patterson & Han, 2019). Parmaxi and Demetriou (2020) stated the importance of having a proper AR theoretical perspective in the classrooms supporting pedagogical decisions with no well-defined theoretical framework. The authors stated that more rigorous research is needed to contrast specific AR features and develop an AR framework. The study results also contributed to developing new guidelines for developing AR instructional material (Han et al., 2022; Parmaxi & Demetriou, 2020). Sommerauer and Müller (2018) stated a need for new solid guidelines as current and future AR developments would incorporate many input devices. These devices included total hands-free AR, gesture and facial expression recognition, and audio and video capturing analysis.

In addition to providing an understanding of critical issues preventing instructional designers from using AR, the results of this study laid the groundwork for future studies on similar subject contexts. The results of my study also provided many new directions for further research on one or more reasons for instructional designers not using AR. Furthermore, the results presented in the research paper could incentivize instructional designers to get creative and research AR independently. They can delve into developing AR instructional material and help bring AR into mainstream educational and professional training.

Definitions of Key Terms

Artificial Intelligence (AI)

AI is a machine with an approximation of human intelligence. Theoretically, the machine should be able to learn from examples and employ the accumulated knowledge in solving challenging tasks (Mouloodi et al., 2021).

Augmented Reality (AR)

AR is an interactive learning environment where software overlays virtual objects, animations, texts, data, or sounds in a physical, real-world environment that the user views from any digital display, e.g., smartphones, tablets, and head-mounted displays (Sommerauer & Müller, 2018).

COVID-19 (Also known as Coronavirus 2019)

It is a global infectious disease originating in Wuhan, China, on December 31, 2019 (Moore et al., 2020).

Digital Media

Media is produced programmatically by a user using visual and audio technological means. Sometimes, the user uses previously created digital media to produce externalized media products (Bateman, 2021).

Head-Mounted Display (HMD)

HMD is a wearable virtual reality device that places small screens in front of the user's eyes to remove the vision of the outside world. It uses stereoscopic or monoscopic views, providing a wide field of view. It usually includes a head tracking sensor, allowing users to look at the surrounding virtual environment by turning their heads (Amprasi et al., 2022).

Instructional Design

Instructional design is a systematic method to formulate appropriate instruction, stimulate the learners' cognitive structures, and utilize instructive descriptive and prescriptive learning theories (Karthik et al., 2019).

Virtual Reality (VR)

VR is a computer-generated artificial environment that a user can experience and explore through sensory stimuli and where the users' actions determine the subsequent events that unfold in the environment (Kamińska et al., 2019).

Summary

This chapter introduced the study and provided specifics, including background information. The chapter also provided the problem and purpose statements, conceptual framework, research questions, research methodology and design, and significance of the study. In addition to introducing the study, this chapter also provided a proposal for conducting the study.

In this chapter, I discussed how the COVID-19 pandemic created a need for a rapid transition of learning material to an online environment for both learning institutions and the professional workforce. In addition, I discussed how AR is an ideal interactive learning environment for in-class and remote online learning. I also listed AR development tools an instructional designer can use to develop interactive AR material. Despite the availability of various AR development tools, I discussed how there were few AR applications in education, training, and industry and the need to determine what barriers instructional designers encountered that prevented them from developing AR material. In this chapter, I proposed researching the instructional designers' AR acceptance level and their willingness to use AR in their curricula.

My proposed research method and introduction to the conceptual frameworks, consisting of the ASSURE, TPCK, and Kirkpatrick models, were presented in this chapter. I also discussed the need for AR development guidelines and models. I concluded the chapter by discussing the study's significance and importance to education, the professional environment, and future studies.

Chapter 2: Literature Review

The purpose of this qualitative hermeneutic phenomenological study was to explore instructional designers' perceptions regarding the factors influencing their reluctance to incorporate augmented reality (AR) into course designs. The problem addressed in this qualitative hermeneutic phenomenological study was the limited understanding of the perceptions and experiences of why instructional designers are not using augmented reality as part of their course development practice. Through this study, I aimed to uncover how instructional designers perceived using AR as a matter of practice. Any additional information obtained through the study was beneficial in understanding the comfort levels and any hindrances instructional designers had in using AR. From the research gathered, there were many articles on tangential subjects. One such study was by Belda-Medina and Calvo-Ferrer (2022). In this study, the authors researched pre-service teachers' digital competence and attitudes using AR. Another study by Njiku (2022) researched instructors' attitudes toward technology integration and TPACK. Dong et al. (2019) investigated the technostress and computer self-efficacy teachers experience in integrating technology into their curriculum. Still, there was no research on instructional designers' use of augmented reality in their courses.

In this literature review, I evaluate current research on reality technologies in education. The literature review consists of five main sub-topics: the conceptual framework, a discussion of AR versus virtual reality (VR), the use of AR and VR in education, an overview of the tools used to create AR content, and the future of AR in education. In this review, VR provides the reader with a similar technical tool for comparison to AR. It could be that the reader is familiar with just one of the tools but not both. Therefore, contrasting the two will give readers a well-grounded understanding of the differences.

The methods and databases used for this study were as follows: The databases searched were Academic Search Complete, APA PsycInfo, Business Source Complete, Education Research Complete, ERIC, IEEE Xplore Digital Library, ProQuest Central, ScienceDirect, and Springer Nature Journals. The search engines used in order of most to less frequently used were Roadrunner and Google Scholar. The search parameters were for articles between the years 2019 and 2023. This bracket would quasi-guarantee relevant search results. There were instances when more details were needed, requiring opening the years' search bracket.

The articles required for this study covered a broad breadth of topics requiring various combinations of keywords using Boolean operators and the wildcard characters "*" and "?". The topics searched were education, instructional design, instructional framework, immersive learning, COVID, constructivism theory, situated cognition, situated learning, socio-cultural, and professional development. In addition, there was a search for technological or virtuality topics such as virtual reality, augmented reality, virtual classroom, virtual learning, remote learning, e-learning, connectivism theory, digital natives, and digital generation.

Conceptual Framework

There is a need for better training in AR technology among educators and instructional designers. The results of one study concluded that there is an educational need for good content, implementation, and evaluations in every AR process (Baran et al., 2020). Another study showed the importance of the teachers' willingness, familiarity, and skills needed to use AR in the classroom effectively (Ashely-Welbeck & Vlachopoulos, 2020). In their research, Huertas-Abril et al. (2021), Tulgar (2019), and Belda-Medina and Calvo-Ferrer (2022) found that teachers also need specialized training to develop AR learning content. Through observation, Kale et al. (2020) found that teachers can not relate the use of technology to content. Along the same lines, insufficient teacher preparation and professional development contributed to the courses' lack of content and technology alignment (Sickel, 2019). Trust et al. (2021) found that teachers failed to see AR's utility in education due to their sciolism with the technology and its affordances. Nikimaleki and Rahimi (2022) also attributed teachers' reservations about incorporating AR into course material to a lack of instructional design, competency, and technology knowledge.

Instructional design is essential in traditional and technological learning environments; nevertheless, instructional designers are not establishing learning objectives or organizing learning activities to include AR. Digital natives, students born into a technological world, have grown up immersed daily in digital technology and are proficient with multitasking and multiprocessing (Smith et al., 2020; Tóth et al., 2022; Wilson et al., 2022) and their learning needs are different from the traditional pedagogy. Digital natives want to learn skills they can apply through practical classes and workshops. Since most instructors are digital immigrants, they must invest time in learning how to effectively use information technology such as AR when developing courses (Kuznetsova & Sos, 2020; Smith et al., 2020). Instructors are prone to utilize the latest technology to interest students in the novelty and not integrate sound pedagogy and defined instructional goals (Sickel, 2019). Kuznetsova and Sod (2020) recommended that instruction begin with presentations and end with AR and VR technology.

Educators need better training in AR technology to understand how digital natives view and use technology. In some studies, the authors identified predictors for the willingness of instructors to use AR, such as prior knowledge, motivation, and an optimistic mindset (Belda-Medina & Calvo-Ferrer, 2022). Still, Belda-Medina and Calvo-Ferrer (2022) concluded that educating teachers on AR still needs much research since most research has participants as recipients, not AR content developers. Luckily, technology has advanced to the point where there are now sufficient software development kits (SDK) to aid instructors and learners in developing individualized projects. Once the educators or learners complete a project, the instructor can integrate it into the classroom, but this process will require technical and pedagogical training (Huertas-Abril et al., 2021; Sickel, 2019).

Many authors listed a lack of knowledge of theories and pedagogical philosophies as instructors' principal problem in integrating AR into the classroom (Kerr & Lawson, 2020; Oliveira da Silva et al., 2019; Pellas et al., 2019; Sickel, 2019). According to Özçelik et al. (2022), some primary learning theories that can guide the use of AR are Constructivism, Socio-cultural theory, and Connectivism. Socio-cultural theorists claim meaningful learning requires the innate capacity to learn and social interaction with cultural elements (Özçelik et al., 2022). The socio-cultural learning theory ties in directly with the situated learning theory, which is covered later in this section. Additionally, Scavarelli et al. (2021) and Belda-Medina and Calvo-Ferrer (2022) list the three most common learning theories used for AR and VR integration: Constructivism, Connectivism, and Situated Learning. The constructivism and connectivism learning theories align with Özçelik et al.'s study. Descriptions of the three learning theories discussed by Scavarelli et al. (2021) and Belda-Medina and Calvo-Ferrer (2022) follow:

Constructivism

Constructivism theorizes that learners construct knowledge through active learning and experiencing rather than being recipients of the information. An old Chinese proverb says, "I hear, and I forget. I see, and I remember. I do, and I understand." Constructivists believe learners gain knowledge through a dynamic process of creating hypotheses and building new ways of understanding through critical inquiry instead of passively receiving information (Kibuku & Ochieng, 2019). Some theorists perceive constructivism as a learning theory instead of an instructional one where the teacher is the facilitator and helper (Yoder et al., 2021). Kibuku and Ochieng (2019) posited that researchers cannot come to a consensus on what constitutes an effective constructivist teacher. The authors state that teachers consider subject matter mastery secondary in constructivism and complain that they wish to educate students in a regular classroom setting where the students perceive them as authorities in the subject matter.

Its implication for AR/VR is that instructors should provide interactive virtual activities that permit collaborative learning and allow learners to control their learning process. Kaimara et al. (2019) state that mobile reality programs enable student-centered learning and promote student collaboration, fostering a deeper understanding of the content. In using AR/VR in the classroom, the teacher's role will be less defined and more passive, shifting their teaching model from instructor-centered to learner-centered (da Silva et al., 2019; Karthik et al., 2019; Kibuku & Ochieng, 2019; Sadikin & Martyani, 2020; Videnovik et al., 2020). When developing the AR instructional curriculum, a couple of studies recommend a similar outline in designing the lesson plans, which entail focusing on interactive group activities that stimulate discovery and reflection from real-life situations (Fan et al., 2020; Kumar et al., 2022; Tugtekin & Odabasi, 2022).

Therefore, through the virtual constructivism environment, the learners can make meaning from the activities provided, such as teachers' instructions, content, and interaction tools. Scavarelli et al. (2021) found that in the context of constructivism and experiential learning in a real-world virtual environment, the learners were motivated to learn the subject matter, increased their spatial knowledge, and could relate to the experiential learning material. Zhang et al. (2019; 2020) mentioned that "learners can acquire contextualized linguistic and content knowledge from the AR-based language learning materials, internalize and construct the knowledge, and then use the obtained knowledge in productive tasks." Sarigoz (2019) found that courses designed with an AR foundation foster the principle of learning by experiencing the constructivist approach. Arici et al. (2019) stated that another factor in an AR constructivist approach is that learners learn by doing through active learning. Terblanché (2019) further discussed that it is necessary to have a more engaging electronic learning environment supported by constructivism and connectivism. Huertas-Abril et al. (2021) expounded that today's traditional classroom setting is ineffective in helping learners construct their knowledge through experience and interaction since they receive primarily visual and auditory stimuli. However, not all schools can take a constructivist approach. As one instructor stated, the resources to perform experiments in the classroom are scarce, so his students must resort to their learning by "just looking in the book" (Brown et al., 2021, p. 23). Other authors, such as Kibuku and Ochieng (2019), found that constructivist e-learners have difficulty making sense of the content and relating to the numerous interaction technologies.

Connectivism

Connectivism theory postulates that knowledge is in a network of Learning Communities. Knowledge in this network does not flow in a single direction to reach its destination; instead, it is continuously aggregating, growing, and evolving. Özçelik et al. (2022) and Zhang (2021) defined connectivism as a new contemporary theory about learners establishing connections between the technology-enhanced environment and learning opportunities through interaction and collaboration. Kibuku and Ochieng (2019) stated that in connectivism, learning occurs when a learner participates in the community by contributing knowledge or withdrawing knowledge from the network. They further defined a learning community as a group of people with similar interests, promoting communication between members and sharing ideas, knowledge, and problem-solving.

Alfuqaha (2013) affirmed that people tend to retain about 20% of what they see and about 30% of what they hear. Those who learn through hearing and seeing retain about 50%, and those who simultaneously see, hear, and do retain about 80%. Digital technology, integrated into learning, accommodates all these three senses. Terblanché (2019) stated that because digital technologies accommodate all these senses, the net infusion is incontestable in the learning communities that connect, communicate, collaborate, and share knowledge. According to Kibuku and Ochieng (2019) and Bizami et al. (2019), members in the learning communities support each other in their learning process, participate in projects, engage in discussions, exchange ideas, learn from their environment, and participate in collective socio-cultural events.

Bizami et al. (2022) found that students of the twenty-first century desire immersive heutagogy because it allows them to actively connect and collaborate with other students in a low-risk environment while giving them a sense of identity within the group. Bizami et al. (2022) described heutagogy as giving learners autonomy in deciding and determining what and how they want to learn. Heutagogy is a non-linear learning methodology with no formal curriculum, and it is up to the learner to define the learning outcome to be followed (Blaschke, 2021). According to Blaschke (2021), this non-linear learning path includes connectivism, collaboration, and communication for acquiring new knowledge.

From a learning process perspective, Zhang (2021) stated that connectivism is a social interaction where instructors regularly emphasize continual and group interaction. Group interaction hones in on the spatial aspect of the exchange, whereas continual interaction focuses on the temporal aspect. Zhang (2021) further discussed that when using connectivism, the learners acquire knowledge through continuous interactions in network connections, whether they be resources or individuals. Terblanché (2019) emphasized that the fundamental principle of distributed cognition lies within the distributed knowledge embedded among different people and equipment. Terblanché (2019) further stated that connectivism results in learners acquiring knowledge when different information is connected, affecting a clearer understanding of a phenomenon. The learning outcome happens when members of the network environment use their comparable capabilities in an equal learning space to search for information and learn from one another. An effective learning outcome with connectivism would include ameliorated problem-solving abilities, information-mining abilities, and group and independent learning (Zhang, 2021).

Kibuku and Ochieng (2019) defined connectivism as being techno-centric and that its equivalent pedagogies require modern interconnect technologies. In connectivism, learning communities and social networks rely on technology to connect and share knowledge. The authors added that the problem with techno-centric pedagogies is that they are continuously evolving, and connectivism is unclear about emerging technologies. Additionally, these techno-tools may distract the students from learning the content that is supposed to facilitate their learning. Therefore, Kibuku and Ochieng (2019) postulated that distractions from technology could prevent learners from achieving their goals. Softić et al. (2022) stated that today's students, digital natives, are born in the digital age and are comfortable using digital technology, so its second nature use would not be a distraction. Softić et al. (2022) recommended that the instructors adapt and tailor their instruction to include digital technology for this new generation of learners.

AR technology, which is context-based, allows learners to bridge their learning skills with a real-world contextualized environment (Özçelik et al., 2022). From a connectivism perspective, AR implies that instructors should provide interactive virtual activities that permit learner participants and active instructors to collaborate and share knowledge within a real-world augmented contextualized environment. Moore (2020) stated that this virtual interactive activity encourages flexible and context-specific instruction. Kibuku and Ochieng (2019) emphasized that the teachers' role in the learners' participation in a technological environment would not be limited to facilitation but would include help and support, mainly when dealing with complex content.

Theorists cannot determine whether connectivism is a theory of learning or teaching, yet many concur that it is a theory of knowledge and its organization (Terblanché, 2019). Therefore, it is not easy to map it into pedagogical practices since it is challenging to incorporate it into learning and much more into teaching. Kibuku and Ochieng (2019) mentioned that teachers are detached and foreign in connectivism except when participating as fellow network contributors or facilitators. The authors also mentioned that this separation is detrimental to the learner since the learner almost always needs an instructor to help navigate the learning content and activities. Kibuku and Ochieng (2019) stated that the instructor must also authenticate and validate the information and critically analyze the learning content with the student.

A drawback to connectivism is that it foments a loss of class control. Kibuku and Ochieng (2019) stated that learners learn best when under some control, similar to a conventional classroom setting. Another drawback of connectivism, according to Kibuku and Ochieng (2019), is that it depends on critical resources such as electricity, the Internet, and hardware to interconnect. In addition, the participants must receive training on the use of the technology.

Although the drawbacks of connectivism are few, it does consider the digital age and the assumption that people do not stop learning after completing their education (Radianti et al., 2020). Radiante et al. (2020) provided examples showing how individuals continue to search and gain knowledge through technology tools. Continuous active learning is a constructive process known as constructivism (Lu et al., 2021; Radiante et al., 2020). Constructivism, social constructivism, and situated learning are three learning theories that work well with connectivism and guide the use of AR since they all have some features associated with AR (Downes, 2019; Parmaxi & Demetriou, 2020; Özçelik et al., 2022; Sarigoz, 2019).

Behaviorism is another learning model suggesting that conditioning or interaction with the environment molds all behaviors through positive or negative reinforcement (Radianti et al., 2020). A search through the literature provides no references to the use of the behaviorism theory and AR. Sommerauer and Müller (2018) also stipulated that they could not find any article using behaviorist theories with AR.

Situated Learning

Situated learning theory posits that a learner acquires knowledge when placed in an authentic activity and learns from realistic contexts and socio-cultural situations rather than through abstraction (Lave & Wenger, 1991). Brown et al. (1989) contended that knowledge and cognition are the learners' products of their interaction within their environment. The same authors proposed the concepts of situated cognition and situated learning. They indicated that the learners build knowledge through participation in actual activities. Wu and Chen (2022) discussed how learning activities should include culture to encourage learners to interact with known situations to gain knowledge and use the knowledge as a tool in natural environments. Many authors found that by using this approach to learning, the learner can combine life experience with the current situation to solve the learning situation producing knowledge that is well-understood and meaningful (Chan et al., 2021; Chen et al., 2020; Chen et al., 2021; Chen et al., 2022a; Dreger & Ticknor, 2022; Liyanawatta et al., 2022; Thurber et al., 2021; Wu & Chen, 2022).

Situated cognition theory, known by many names, such as cognitive apprenticeship, situated learning, legitimate peripheral participation, and more, shares a common idea that cognition is situated, and learning goes hand-in-hand with doing in situ. In their article, Greeno and Moore (1993) discussed how they introduced the term "situativity" to describe situated cognition and learning. They claim that "situativity theory is that cognitive activities should be understood primarily as interactions between agents and physical systems and with other people" (p.49). Believing that learning is social would imply that learners will gravitate to communities that share their interests. As various authors have mentioned, when learners interact with people of like minds, learners benefit from the knowledge of those who are more knowledgeable (Bizami et al., 2019; Kibuku & Ochieng, 2019; Terblanché, 2019; Zhang, 2021). These social experiences provide learners with authentic situations or problems. Numerous studies have shown that learners feel motivated to learn when they find themselves in these experiences (e.g., Blaschke, 2021; Jia & Liu, 2019; Nikimaleki & Rahimi, 2022; Upadyaya et al., 2021; Wu & Chen, 2022). Schunk (1996) defined another similar theory, Social Cognitive Theory, in which learning happens within a social environment. The student learns through observation and emulation of others.

Brown et al. (1989) stated that in situated cognition, the primary goal of cognitive activity is to help students think as professionals solving a particular problem within a given context. The students become professionals by incorporating into the learners' community and becoming members of the learning culture. Seniuk Cicek et al. (2020) elaborated on this concept, stating that the focus is on helping all learners transition from novices to experienced independent professionals. The learners become individuals who learn to use their expertise, intuition, and profound understanding to solve their chosen problems. Brown et al. (1989) contended that knowledge transfer occurs when the natural learning environment captivates the learner in solving authentic, complex, non-routine issues based on real-life situations.

Situated learning's implication for AR/VR is that instructors should provide learners with real-world situations. These authentic environments might otherwise be unavailable to the learners due to the high cost of the equipment and its related software or limitations on the physical space. Scavarelli et al. (2021) defined this type of constructivist learning as situated learning, where learning is situational. Scavarelli et al. (2021) and other researchers illustrated how immersive AR/VR could help learners explore environments and situations that would otherwise be difficult to explore in real life. They provided examples such as teaching abstract contexts in non-Euclidean geometry or the physically impossible visit to the surface of Mars (Alfadil, 2020; Pellas et al., 2021; Sahin & Yilmaz, 2020; Steffen et al., 2019; Tugtekin & Odabasi, 2022; Yilmaz & Batdi, 2021). With the availability of digital tools, instructors can develop virtual learning environments for learners limited only by the developers' vision and available hardware, providing the students the opportunity to experience situations and psychologically stressful environments without harm (Kwon & Morrill, 2022). With immersive and situated learning, learners can travel virtually to other countries, visit historical situations, or learn skills in situ. Chia-Chen et al. (2022) summed it up by saying that "creative situated augmented reality learning refers to constructing a learning environment that simulates the real situation and supports creativity through AR technology" (p. 154). Because AR/VR increases the sense of being situated in the environment without physically being there and performing activities in a natural environment, this technology enables a new application of situated learning.

According to Eslahchi and Osman (2021), the situated learning theory does have some limitations. For example, the theory centers on how a learner progresses from being a novice in the community to becoming a professional by learning existing knowledge from that community in a specific context. However, it does not explain how the community can learn anything new. In a study by Seniuk Cicek et al. (2020), the authors described learners' dilemma in advancing from novice to expert because of the lack of community in their institution. Another issue that Eslahchi and Osman (2021) raised is that situated learning focuses on accomplishments and not on what the learners learn – perceiving that all learning is good. Based on studies and reviews done, we cannot discard that technology can enhance situated learning (Al-Hakim et al., 2022; Chia-Chen et al., 2022; Di Natale et al., 2020; Dreger & Ticknor, 2022; Scavarelli et al., 2021; Wu & Chen, 2022). However, Donald Norman in Chang et al. (2020a) raised an antipode that the new technological tools are moving us to accept experiences as an ersatz for thinking.

Teacher Augmented Reality Training and Challenges

Concerning teacher training, some studies used various models to examine teachers' and pre-service teachers' readiness and attitudes toward AR integration in different disciplines (e.g., Ashely-Welbeck et al., 2020; Belda-Medina & Calvo-Ferrer, 2022; Huertas-Abril et al., 2021). Wei et al. (2021) conducted a study exploring educators' readiness to use AR as an enhancement teaching tool. They found that most teacher participants are familiar with AR and believe AR can enhance teaching and learning. They also observed that educators are ready to adopt AR as a teaching enhancement tool. Other studies focus on teachers' challenges in integrating AR into the classroom (e.g., Ashely-Welbeck et al., 2020; Huertas-Abril et al., 2021; Saleem et al., 2022;

Scavarelli et al., 2021). Belda-Medina and Calvo-Ferrer (2022) found that one of the significant difficulties pre-service and in-service teachers had in integrating AR into education was their lack of knowledge of theories and pedagogical principles. The same studies focusing on teachers' challenges indicate that teachers lack technical training and a model tailored to technology use. Yasir et al. (2022) mentioned that some teachers rarely use computer-based learning media because they are less creative and innovative in developing science courses. Studies show that when instructors develop courses that implement AR, ADDIE (Analysis, Design, Development, Implementation, Evaluation) (see Figure 4) is the model framework most used for AR course development. The ARCS (Attention, Relevance, Confidence, Satisfaction) model (see Figure 5) is the next most used (e.g., Bacca et al., 2019; Hoa & Lee, 2021; Laurens-Arredondo, 2022; Nadi et al., 2021; Sari et al., 2022; Suprapto et al., 2020).

Figure 4

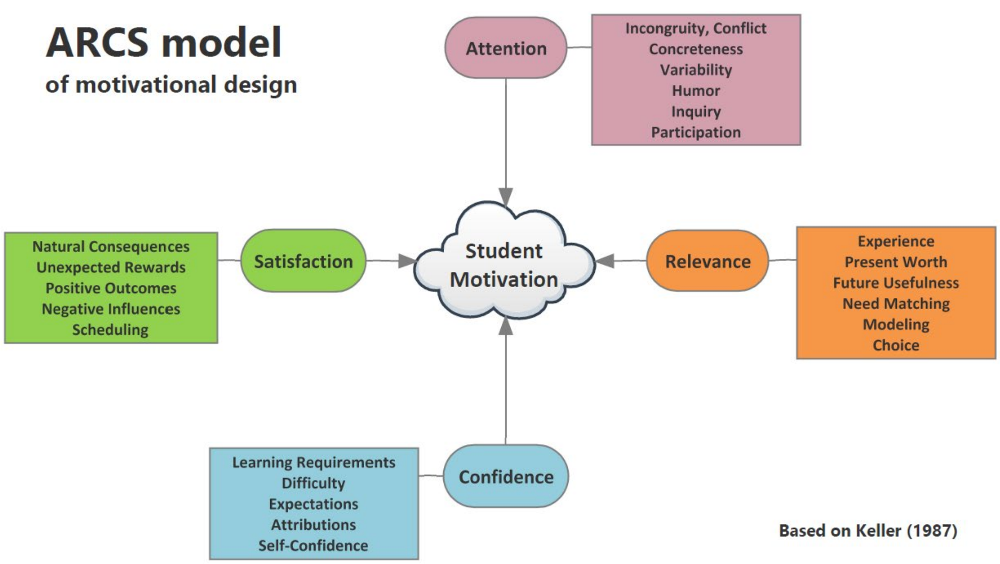
ADDIE Model

Note. ADDIE (Analyze, Design, Develop, Implement, Evaluate). It is used in two ways by instructional designers when designing a course. First as a framework for course development and later as a process for creating multimedia projects. (Peterson, 2003) Image from Centers for Disease Control and Prevention (https://www.cdc.gov/training/development/addie-model.html).

As an example of an AR ADDIE model framework used by Suprapto et al. (2020), the researchers developed an AR-based pocketbook to facilitate the learners' understanding of abstract material concepts concerning planetary motion. The researchers analyzed the teachers' and learners' instructional media needs for the analysis stage. In the design stage, the researchers created a prototype design, and in the development stage, they realized the prototype. The researchers conducted the study during the COVID-19 pandemic; therefore, the researchers implemented and applied the AR-based pocketbook design online. The evaluation stage consisted of pretests and posttests.

Figure 5

ARCS Model



Note. ARCS (Attention, Relevance, Confidence, Satisfaction). Keller developed this Model as a response to finding effective ways of understanding learning motivations and identifying and solving motivational learning problems. (Keller, 1987). Own work.

Researchers Hao and Lee (2021) developed four AR games for learning in a fifth-grade English course as an example of using the ARCS model for an AR application. The teaching materials included stories of Aladdin, 3D animations, and a tablet. For attraction, the games had surprise situations, offered challenging questions, and used a variety of resources and methods of teaching. For relevance, the games had familiarity (previous experiences), the relevance of teaching and personal objectives, goal orientation, whether through autodidact or cooperative learning, and a sense of winning. The games instilled confidence through positive expectations, successful opportunities, and self-controlled learning. Lastly, the games provided satisfaction through intrinsic reinforcement and extrinsic rewards and maintained consistent standards.

Even though some teachers use these ARCS characteristics in their pedagogics, the techniques are decades old. Developing emergent learning scenarios requires new design frameworks to improve AR technology's potential (Kazanidis et al., 2021). Czerkawski and Berti (2021) stated that educators usually do not have foundational learning experience design approaches with instructional design models and fail to incorporate technology into their content. Kale et al. (2020) pointed out that teachers minimally connect technology to their content areas. Pathania et al. (2021) deduced from their literature review that learners need effective customizable content, portability, and connectivity with instructors and other students through AR.

As discussed in Chapter One, three conceptual frameworks supported this study and applied to instructors in AR-tailored coursework. The three conceptual frameworks are the ASSURE, TPCK (TPACK), and the Kirkpatrick model. What follows is a discussion of these three frameworks.

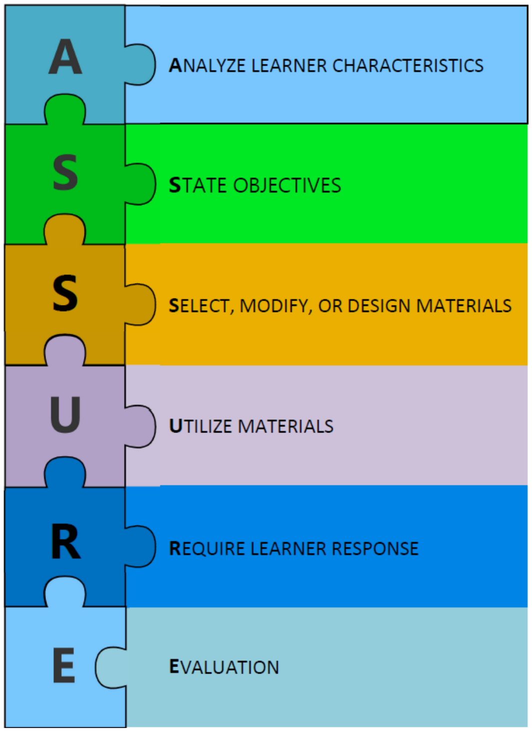
Frameworks

Based on a study by Giacumo and Breman (2021), the top five most utilized frameworks and models used by instructional designers are ADDIE, Performance Gap Analysis, Kirkpatrick, Agile, and Rapid prototyping. The authors did not consider frameworks or models used for AR instruction. The ASSURE model enhances the ADDIE model by incorporating media into the instruction (IGI Global-Information Resources Management Association, 2020, pp. 81, 87). It is fitting to choose the frameworks ASSURE, Kirkpatrick (for its four levels of evaluation), and TPCK (TPACK) models for the initial framework selection of this study.

ASSURE Model. Heinrich and Molenda developed this Model in 1999 (see Figure 6). Their purpose for developing the Model was to guide instructors in planning and delivering classroom lessons integrating technology, media, and materials (Kim & Downey, 2016). The Model incorporates Robert Gagne's nine events of instruction to ensure the effective use of media in instruction. As Stefaniak and Xu (2020) stated, it is "an enriched and evolutionary instructional systems design framework developed from the ADDIE model" (p. 714). Heinich et al. (1993) described this Model as unique in its focus on planning and conducting instruction that integrates media. The ASSURE model provides inexperienced instructors with a roadmap for developing and improving the educational environment (Fiandra et al., 2022).

Figure 6

ASSURE Model



Note. ASSURE (Analyze learner, State objectives, Select instructional methods and materials, Utilize media and materials, Require learner participation, and Evaluate and revise). A potential model for designing technology-enhanced didactic instructions (Jiwak, 2019). Own work.

Regarding AR, during the evaluation stage, the designer would evaluate the functionality of integrating all the educational technology components. Liu (2019) did a tangential study where he evaluated online learning readiness and success of online learning. The evaluation consisted of analyzing and measuring the effectiveness of the training material. Measuring the effectiveness of the technology and educational content integration provided a base to calibrate and adjust existing courses. In AR, when using the ASSURE model, the instructional designer would use the evaluation stage for the same type of effectiveness evaluation as in Liu's study.

In another study by Kilty and Burrows (2019), the authors performed a study to determine if a need for instruction existed for instruction in engineering and if instruction could change the learner's perception. The authors used the ADDIE model to design the course in which ASSURE is an offspring. The evaluation phase determined if the course effectively changed the learner's perception. Regarding AR, in the evaluation stage, it will be determined if the technology effectively made the abstract known. Amara et al. (2021) stated that using AR and VR increases the learners' participation and understanding of complex spatial structures and functions and helps them understand complex abstract topics.

Kirkpatrick Model. Donald Kirkpatrick first introduced this evaluation model in 1959. The Model provides a framework for evaluating and analyzing the results of educational, training, and learning programs. The Model assesses formal and informal training methods, rating them against four criteria levels. These four criteria are known as Kirkpatrick's Four Levels of Evaluation: Reaction, Learning, Behavior, and Results.

As outlined in the system, evaluation needs to start with level one and successively progress through each following level. Each successive level is a more precise measure of the training program's effectiveness. If a level lacks positive results, the instructors consult data from the previous level before making any modifications. Utilizing this Model helps ensure that training programs are developed and delivered to maximize learning (Kirkpatrick & Kirkpatrick, 2016). See Table 1 for a list of level definitions.

Table 1

The Four Levels

Levels	Definitions
1: Reaction	The degree to which participants find the training favorable, engaging, and relevant to their jobs.
2: Learning	The degree to which participants acquire the intended knowledge, skills, attitude, confidence, and commitment based on their participation in the training.
3: Behavior	The degree to which participants apply what they learned during training when they return to the job.
4: Results	The degree to which targeted outcomes occur due to the training, support, and accountability package.

Note. Adapted from "Kirkpatrick's Four Levels of Training Evaluation" by Kirkpatrick and Kirkpatrick (2016).

Kirkpatrick's Model has been used extensively in evaluating work-based assessments. Sahni (2020) used it to investigate the effectiveness of a managerial training program, and Aryal et al. (2021) evaluated the usefulness of work-based assessments in surgical training. Rey-Becerra et al. (2021) discussed the analyzed results of a virtual safety training program, and Manzoor and Zia-un-Din (2019) measured the effectiveness of the Pakistan Police training program. These studies suggest a trend in applying the Kirkpatrick model to education and training in virtual environments. The authors provided negligible information in their studies on applying the Model beyond questionnaires for the evaluation phase. The lacuna is not uncommon since, according to Stefaniak and Xu (2020), many studies have instructional design models that guide their designs; nevertheless, the authors do not indicate how the models influenced the design activities associated with their study.

As previously shown, many studies on work-based assessments use the Kirkpatrick Model. Few are using Kirkpatrick's Model with virtual technology. Carnell et al. (2022) reiterated that instructional designers often consider the Kirkpatrick model the gold standard for evaluating training but not for virtual environment-based training. The authors discussed that the evaluation of virtual environments should regard user experience and the efficacy of the training or learning to ensure learning transfer. Other evaluation models exist to assess training scenarios, but these frameworks, including Kirkpatrick's, have not been employed in developing virtual environments for education and training (Carnell et al., 2022).

TPCK (TPACK) Framework. Mishra and Koehler initially proposed TPCK in 2005 (Koehler & Mishra, 2008; Koehler & Mishra, 2005a, 2005b; Mishra & Koehler, 2006). They evolved their framework from Shulman's (1986, 1987) work regarding pedagogical content knowledge (PCK) (Smith & Zelkowski, 2022; Zhang et al., 2019). Shulman (1986) concluded that effective teachers excel in the union of content knowledge (CK) and pedagogical knowledge (PK). To this end, Mishra and Koehler (2006) added Technological Knowledge (TK) as a third domain to Shulman's framework to produce the current TPACK framework.

The TPACK framework consists of three main knowledge domains, as described by Koehler and Mishra (2008). They consist of content knowledge (CK), pedagogical knowledge (PK), and technology knowledge (TK) domains. The intersection of these domains creates three overlapping areas. These overlapping areas are known as technological content knowledge (TCK), technological pedagogical knowledge (TPK), and pedagogical content knowledge (PCK) domains. The full spectrum of all the domain intersections is known as technological pedagogical content knowledge (TPACK). Mishra and Koehler (2006) cautioned that TPACK is not a single schema suitable for all circumstances. Instead, TPACK is the knowledge that gets applied differently to each teacher across different courses and philosophies of teaching.

TPCK was the original acronym proposed by Koehler and Mishra (2005b). Since people did not know how to pronounce or remember it, the authors Thompson and Mishra (2007) added the conjunction "and" to finalize TPACK (Technological Pedagogical AND Content Knowledge) to make the acronym easier to pronounce and remember. Marketing tried promoting the framework as Total-PACKage, but it never caught on. However, adding the conjunction "and" gave a more profound implication of the necessity of three kinds of knowledge: content, pedagogy, and technology to form a complete product by integrating the three pieces of knowledge (Zhang & Tang, 2021). Therefore, by integrating the three pieces of knowledge, Thompson and Mishra (2007) viewed the TPACK framework as a Total-PACKage for teaching using technology (Zhang & Tang, 2021).

Researchers have stated how important it is for teachers to know about integrating technology into teaching. Mishra (2019, p. 76) described the TPACK framework as highlighting the knowledge teachers need to integrate technology into teaching successfully. Zhang and Tang (2021) and Njiku (2022) also agreed with Mishra's statement that the TPACK framework describes the knowledge teachers require to integrate technology into teaching successfully. Njiku (2022) further found that instructors using the TPACK model could readily integrate technology after participating in professional development programs. Chai et al. (2013) in Lu et al. (2022) stated that TPACK comprehensively details teachers' knowledge and skills required to teach with technology.

By adding TK, the authors Mishra and Koehler (2006) posited that those technological tools are apart from content and pedagogy and necessary for classroom teaching. Digital tools require instructors to consider new content and pedagogy intersections (TPK and TCK). The TPACK model's understanding arises from overlapped content, pedagogical, and technological knowledge (Zhang & Tang, 2021). A brief explanation of the various domains depicted in Figure 5, as explained by Zhang and Tang (2021), follows:

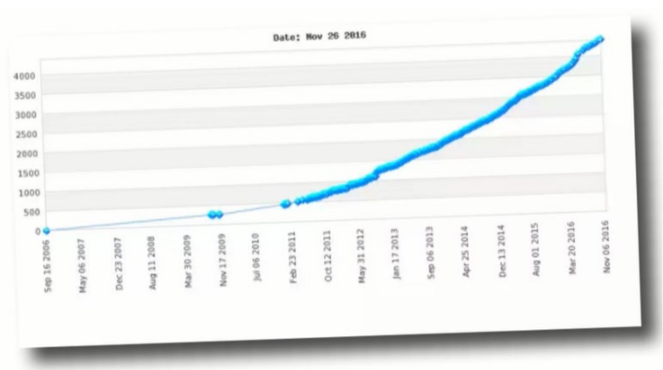
- Content Knowledge (CK): Any subject-matter content for which the teacher is responsible for teaching.
- Pedagogical Knowledge (PK): This area represents a teacher's knowledge of the various instructional practices, strategies, and methods that promote learning.
- Technological Knowledge (TK): This area refers to a teacher's knowledge of integrating traditional and new technologies into the classroom.
- Technological and Content Knowledge (TCK): This section represents the knowledge of the shared relationship between technology and content.
- Pedagogical and Content Knowledge (PCK): This is Shulman's (1986) belief in "an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (p. 8).
- Technological and Pedagogical Knowledge (TPK): This area embodies a teacher's knowledge of how technology can constrain and manage specific educational practices.
- Technological, Pedagogical, and Content Knowledge (TPACK): The complete diagram represents the overall knowledge about the complex relationships

between technology, pedagogy, and content, which aids teachers in developing context-specific pedagogical strategies.

TPACK is a framework that has garnished wide acceptance in the educational research community. Mishra (2016) showed how there had been exponential growth (see Figure 7) in instructional researchers, citing TPACK since its introduction in 2006. Green and Jones (2020) reviewed studies of TPACK's usage in English as a Second Language between the years 2009 and 2019. The authors found that self-reporting methods were a common factor in the studies, and there was more of a focus on creating and developing measures of TPACK that consider the context. Zhang et al. (2019) performed an epistemic network analysis on primary school teachers' TPACK in online collaborative discourse. The study's results, as supported by Lu et al. (2022), evince that younger teachers' knowledge was primarily pedagogical knowledge (PK) and pedagogical content knowledge (PCK). Senior teachers have more experience in technological knowledge (TK) and pedagogical knowledge (PK).

Figure 7

TPACK Citation Growth



In a study by Alemdag et al. (2020) involving in-service teachers, the authors argued that the TPACK framework was appropriate for illustrating the knowledge adult learners need to use technology in their professions. In addition, the participants could develop their TPACK and technology integration practices simultaneously after participating in professional development programs. In a similar study, Chaipidech et al. (2022) had in-service adult teachers participate in a study investigating the effects of an andragogical design of teacher professional development with an embedded personalized learning system (PLS) on TPACK. The authors found that integrating a TPAC-oriented PLS improved the teachers' TPACK of integrated STEM (science, technology, engineering, and mathematics) education in all TPACK areas.

Professional Development. The two previously mentioned studies focused on teachers' professional development as a way to secure a technologically enhanced classroom curriculum. Lu et al. (2022) suggested that teachers who attend professional development programs improve their belief in the initialization of technology diffusion. Tusiime et al. (2019) observed that teachers attending *continuous* professional development programs developed digital competency. Huang et al. (2021) stressed the importance of having professional development programs go beyond training basic technology skills so that teachers feel comfortable understanding and implementing emerging technology in different learning environments. Saleem et al. (2021) stated that teacher training requires professional development. Their training provides effective and efficient skills for them and the institution. Scherer et al. (2020) mentioned how teachers find integrating technology into education challenging and must constantly adapt to new technologies and refine their competencies through training. Getenet (2020) found that teachers must be competent in technology, content, and pedagogy to effectively use technology in the classroom. Getenet discussed how teachers could accomplish this effectiveness only through participation in professional development programs with follow-up sessions and continual refresher courses.

Various works of literature manifest that training programs are ineffective due to the lack of emphasis placed on the didactic behind technology use. Dong et al. (2019) stated that teachers do not get enough hands-on experience in training programs, while Smith and Zelkowski (2022) added that the teachers do not put into their classroom instruction what they learned in the training programs. Sims et al. (2021) found that most instructors revert to their old habits after taking professional development programs. When they apply skills or techniques learned, they misapply the skills and generally have a "may work" attitude. Saleem et al. (2021) ascertained that professional development programs for teachers were unsuccessful in bringing about the desired changes. The failure to bring about the changes was due to various factors, such as failure to follow up, no accountability for learned skills, no applicability incentives, and no in-class support. Getenet (2020) said that most professional development programs fail for various reasons. He attributes these failures to the programs lacking durability, continuity, relevance, and pedagogical direction. Lichtenstein and Phillips (2021) further attributed failures to implement new professional development skills to the time required to prepare new technical strategies.

Despite the investments in integrating technology into education, educators are still unwilling or unprepared to integrate technology into their pedagogy and competently use it in their curriculum. Njiku (2022) attributed this failure to integrate technology to various barriers, such as the teachers' inadequate technical skills and limited understanding of technology's pedagogical affordances. Forkosh-Baruch et al. (2021) found that teachers did not have an integrative model to help them shape their decisions and reasonings on technology integration, which was a barrier. Getenet (2020) and Scherer et al. (2020) observed that instructors are unwilling to integrate technology into their courses without professional training. In their research, Jang et al. (2021) found that teachers were not motivated to integrate technology (AR or VR) into their course pedagogy due to the culture of the school and school district. They would not integrate technology unless the teachers received motivational support, including technology leadership from school administrators, teacher collaboration, and teacher professional development opportunities. Kale et al. (2020) observed that while experience with technology is beneficial, teachers will not integrate it into their lessons unless they have a strong foundation of pedagogy and content knowledge and a solid understanding of how it will be relevant to their teaching.

Augmented Reality vs. Virtual Reality

Technology is continuously evolving and making access to information more intuitive. Steffen et al. (2019) discussed how interacting with digital devices has become more natural and how the physical and digital lines are becoming more blurred with each new product iteration. The growing acceptance of AR and VR tools presents promising educational opportunities for developing innovative interactive applications in art education, construction, computer science, engineering, medicine, virtual tours, and immersive microscopic explorations (Bazavan et al., 2021; Kwon & Morrill, 2022). Besides being promising for educational endeavors, the authors Vishnevskaya and Strekalova (2021) added that virtual reality technologies are multifaceted and integral to our lives. As more AR and VR activities integrate into society, knowing and differentiating when and how to use each technology becomes crucial. What follows is a description of each of the technologies.

Augmented Reality

AR is a three-dimensional technology that displays digital information as an overlay into a learner’s tactile observation device. Typically, this device would be mobile, allowing the learner to interact with virtual content. Firat and Firat (2021) defined AR as a technology that dynamically combines a real-world environment with digital contextual information. It adds virtual objects to real scenes by supplementing the real objects with missing information. Buchner et al. (2021) defined AR as a computer-based extension of reality where virtual objects align with real-world objects, allowing users to interact and receive immediate feedback. Many other authors described AR as a tool that combines real and virtual objects to augment the students' learning experience through supplemental video, audio, graphics, or GPS location data (Iqbal et al., 2022; Karacan & Akoğlu, 2021; Karagozlu, 2021; Majid & Salam, 2021; Trust et al., 2021; Tugtekin & Odabasi, 2022; Turan & Atila, 2021; Tzima et al., 2019; Wyss et al., 2021).

AR must be able to track real-world objects to overlay them with digital content. The AR tracks real-world objects through marker-based, markerless-based, and location-based methods (Belda-Medina & Calvo-Ferrer, 2022; Fan et al., 2020; Majid & Salam, 2021; Mystakidis et al., 2021; Özçelik et al., 2022; Pellas et al., 2019; Sarkar & Pillai, 2021; Sims et al., 2021; Tzima et al., 2019). Marker-based AR uses the devices' camera to identify labels (e.g., QR codes), markers, or images to trigger events. Markerless-based AR scans the surrounding environment with the camera to identify objects, such as the locations of walls, which can trigger an event, such as displaying an image or playing multimedia content. Location-based AR events are triggered by the sensors on the mobile device when the user arrives at a geographical location (Afnan et al., 2021; Czerkawski & Berti, 2021; Mystakidis et al., 2021; Sarkar & Pillai, 2021; Özçelik et al., 2022; Tzima et al., 2019). Marker-based AR is the most commonly used method, followed by location-based AR and markerless-based AR being the least used (Maas & Hughes, 2020). One exception is AR in STEM fields. Mystakidis et al. (2021) found that markerless-based usage supplanted location-based usage.

Virtual Reality

VR is a three-dimensional virtual world where learners can explore three-dimensional visual simulations without limitations of time and space. The virtual world can be an imaginary universe or a replication of the natural world, where a learner can experience the virtual environment visually, audibly, and, on occasion, haptically (Elmqaddem, 2019). There are five classifications of VR: non-immersive, immersive, semi-immersive, augmented, and collaborative. Non-immersive is a 3D world where the learner explores a computer-generated simulation using a mouse, keyboard, speakers, microphone, and monitor (Alshammari, 2019; Bower & Jong, 2020b; Di Natale et al., 2020; Maas & Hughes, 2020; Mustafa, 2022).

In immersive virtual reality, learners disconnect from the real world (Alshammari, 2019; Le et al., 2021; Steffen et al., 2019). Immersive VR is considered the highest level of immersion a user can experience (Di Natale et al., 2020; Villena-Taranilla et al., 2022). With a head-mounted display (HMD), learners enter a realistic 3D world where they can move around and interact with virtual objects (Alfadil, 2020; Alshammari, 2019; Chang et al., 2020b; Di Natale et al., 2020; Erkan, 2020; Klingenberg et al., 2020; Maas & Hughes, 2020; Mustafa, 2022; Trust et al., 2021). The most common devices used in an immersive environment are an HMD and haptic feedback gloves to simulate touching and manipulating virtual objects (Di Natale et al., 2020; Mustafa, 2022; Sarigoz, 2019). Kamińska et al. (2019) defined HMDs as devices placed on the head or part of a helmet. The device has a built-in display and lenses that give the wearer a wide-angle view of the virtual world (Di Natale et al., 2020). Other devices can be used in an immersive environment to increase the sense of presence, such as body suits and external sensors such as Kinect (motion tracking system) or MYO Gesture Control Armband (Chan et al., 2021; Innocenti et al., 2019; Kamińska et al., 2019).

Semi-immersive VR is a combination of non-immersive and full-immersion VR. In this partial virtual environment or 3D space, the learner can move around without physical sensations to enhance the experience. The learner experiences realism through enhanced 3D graphics using a computer monitor or VR (3D) glasses (Kamińska et al., 2019). Higher-quality graphics, as provided by a personal computer, gives the learner a more immersive feeling (Bower et al., 2020a). On a desktop computer, the learner moves around using a mouse, keyboard, or gloves to rotate virtual objects (Kamińska et al., 2019). The learner can touch or swipe on mobile devices to move around in the virtual world. Di Natale et al. (2020) stated that semi-immersive systems are more conducive to creating highly embodied experiences but less interactive than full-immersive systems.

The previous section on augmented reality discussed the VR classification of AR, so it will not be covered here. Collaborative virtual reality is a virtual shared environment where various learners can meet remotely or physically to form a group and collaborate (Chen et al., 2022b). In their study, Chen et al. (2022b) listed activities where learners can participate in a collaborative virtual reality, such as VR-based education and training, multi-user gaming, and social networks.

Use of Augmented and Virtual Reality in Education

Various researchers emphasized the importance of learner-centered instruction through virtual reality (Antonioli et al., 2020**;** Buchner et al., 2021; Huang et al., 2021; Kim et al., 2020; Pellas et al., 2020; Sarkar & Pillai, 2021; Yildirim, 2020). Many of the same authors mentioned that through active participation in the virtual environment, the learners are responsible for their learning through continuous interaction. In line with the VR study results of Pellas et al. (2020), Mystakidis et al. (2021) found that AR likewise enhances group work skills, promotes selfregulated learning, fosters engagement in collaborative learning, increases learners' attention span, and is more effective when used as a supplement to traditional lecture-based teachings.

Smink et al. (2021) made known the rapid adaption and acceptance of AR in advertising and consumerism, just as Kumar et al. (2022) described the wide acceptance of AR and VR as collaborative learning tools. Belda-Medina and Calvo-Ferrer (2022) stated that AR has recently become prolific in digital gaming and education. At the same time, other studies have shown that AR can significantly benefit children with learning difficulties such as dyslexia, dysgraphia, and dyscalculia, among others (Cakir & Korkmaz, 2019; Köse & Güner-Yildiz, 2021; Turan & Atila, 2021). AR tools are increasingly coursing into education (Karagozlu, 2021; Wei et al., 2021; Wyss et al., 2021). However, just a few years earlier, Steffen et al. (2019) commented that commercial and educational integration of these technologies has failed despite years of research and commercial attempts. However, the authors did recognize that AR and VR provide promising opportunities for innovative interactive applications like those that Kumar et al. (2021) stated are needed in the classroom. Contrary to Steffen et al. (2019), Trust et al. (2021) published that extended reality technologies such as AR and VR have proliferated in popularity recently. According to various authors, these technologies contribute to ameliorating educational services, facilitating learning experiences, and supporting teaching processes (Afnan et al., 2021; Amara et al., 2021; Radianti et al., 2020; Shen et al., 2022).

Augmented Reality

Various educational disciplines use AR and VR technologies, such as mathematics, geometry, geography, and chemistry (Huang et al., 2021). In a research review, Pathania et al. (2021) supported Huang et al. (2019) statement that various educational disciplines use AR. Mystakidis et al. (2021) found that AR in education can improve learners' conceptual understanding and knowledge and help them acquire new skills such as problem-solving, collaboration, and communication. AR improves learners' performance (Afnan et al., 2021; Huang et al., 2021; Maas & Hughes, 2020), increases motivation and engagement (Afnan et al., 2021; Huang et al., 2021; Maas & Hughes, 2020; Özçelik et al., 2022; Saleem et al., 2020b; Wei et al., 2021; Wyss et al., 2021), and fosters collaboration (Huang et al., 2021; Maas & Hughes, 2020; Özçelik et al., 2022; Wyss et al., 2021). In addition to these AR benefits, there are higher student academic success rates (Karagozlu, 2021) and interest in the subject matter (Afnan et al., 2021; Cakir & Korkmaz, 2019; Huang et al., 2021; Karagozlu, 2021; Wei et al., 2021; Wyss et al., 2021). Zhang et al. (2022) found that students performed better when taught with PowerPoint presentations with multimedia over "chalk and talk." They performed significantly better when AR supplemented the lectures.

Many learning domains have had AR applications developed for research. Chang et al. (2019) presented a model that allows students to learn about interior design interactively by allowing them to place 3D models of virtual objects, e.g., chairs, tables, beds, and floor lamps, on top of a design layout plan using their mobile device. Kouzi et al. (2019) developed an application that allows elementary school children to learn about the human skeletal system through interaction using specialized virtual buttons and a 3D human skeleton model. The children learned the names of essential bones using a tablet. Yang et al. (2019) researched first-grade students learning mathematics using an AR application. The students would try to solve mathematical problems by interactively stepping on markers placed on the ground and reacting to visual and audial feedback. In this AR application, a mobile camera atop a tripod monitored the students' movement as the students stepped on the markers.

The authors Buchner and Jeghiazaryan (2020) developed a model for designing augmented reality books named the ARI^{2}VE Model (AR Interactive, Interplay, Visualization, and Engagement). The authors manifested a double-page spread from a theme pamphlet on an interactive expedition to ancient Egypt. One side of the pamphlet contained textual information, the other had a top section with a trigger image, and the bottom section had the corresponding task. The trigger image brought up a simulation of mummification that the learners could view from all angles and interact with the tools and canopies.

Virtual Reality

VR provides learners with numerous benefits. Some of the benefits listed by Pellas et al. (2020) are enhanced workgroup skills, increased student participation in collaborative learning, learning engagement and discovery, greater self-confidence, and increased student attention span. In addition to these benefits, other authors mentioned emotional engagement (Liu et al., 2020), improved learning outcomes (Lampropoulos et al., 2022b), in situ learning and a sense of presence (Trust et al., 2021), in-depth and student-centered learning (Yildirim et al., 2020), and reduced learning anxiety (Huang et al., 2021; Cheng & Tsai, 2019). Digital natives' innate familiarity with technology easily affords them many benefits (Karacan & Akoğlu, 2021). According to Mado et al. (2022), recent studies showed that VR produces higher learning results than other media; studies before 2018 showed that other media produced higher learning results, yet some recent studies reported no differences between the two conditions.

According to the *2020 EDUCAUSE Horizon Report: Teaching and Learning Edition*, AR and VR are emerging technologies with promising educational futures (Brown et al., 2020). Within the past few years, VR has quickly gained acceptance in education (Villena-Taranilla et al., 2022). With the increased availability of immersive VR (IVR), Liu et al. (2020) stated that students can now engage in various educational subjects. Wu et al. (2020) found that IVR with HMD use greatly benefits the learning performance of K-12 students more than post-secondary students. The same authors discovered that HMDs are more effective than other systems.

Yildirim et al. (2020) said that since schools now have greater access to VR technology, more teachers are experimenting with its use in classrooms. Although it may seem like a substantial uptick in use, Trust et al. (2021) mentioned that in 2019, less than 10% of schools in the United States had adopted VR technology. Contrastingly, according to Mado et al. (2022), as of 2017, 21% of families in the United States with children under 18 owned a VR headset. In the combined years of 2019 and 2020, over 10 million VR headsets were sold worldwide.

Applications in VR cover a vast domain of fields and topics. Wu et al. (2020) discussed an application where a learner could travel inside a blood cell. Cheng and Tsai (2019) researched how students benefited from accessing inaccessible areas and understanding complex processes in virtual field trips. Liu et al. (2020) developed a virtual environment where students could interact with 3D wild animals, such as a Siberian Tiger, Greenhead Duck, Rhinoceros, African Elephants, and other species, and obtain additional knowledge through knowledge items. An intelligent robot would narrate the knowledge items in the virtual environment. There are many applications in foreign language learning where the learner is in a situational setting and must practice listening and speaking (Huang et al., 2021). Huang et al. (2021) found few language applications emphasizing writing and cultural learning. Radianti et al. (2020) reviewed how VR in a construction engineering course enables students to interact with building elements, visualize scheduling information and on-site construction, and work on construction safety training. Students use VR in operative dentistry training to help boost their confidence and knowledge through the virtual practice of various orthodontic procedures (Fahim et al., 2022).

Kamińska et al. (2019) researched virtual reality applications used in various education areas. One area was using VR in engineering training simulators to prepare engineering students for real-world industrial situations. Another area was robotics education and training with visual and haptic feedback-based interaction. Medical VR presents many opportunities to improve the quality of medical skills by learning through haptic devices or avatars. Another, though not the last, the authors presented the teaching of astronomy and space technologies where learners can travel through space and enter a virtual world.

Augmented Reality Tools

The ultimate goal of AR tools is to present content to learners in a 2D or 3D format, combining the characteristics of real and virtual worlds appealing to the learners' different senses (Tulgar, 2019). Martlı and Ünlüsoy Dinçer (2021) also stated that there has to be a need for an AR software interface to interact with both the virtual and real environment. There are various tools available for the creation of AR. However, many AR tools met a swift demise with the continuous development of technologies, as evinced in recent research articles (Fan et al., 2020; Huang et al., 2021; Köse & Güner-Yildiz, 2021; Martlı & Ünlüsoy Dinçer, 2021; Mystakidis et al., 2021; Parmaxi & Demetriou, 2020). Some now-defunct tools referenced are Aurasma, Aurora, Away3D, Metaio Creator, and Papervision3D.

There are two methods for creating AR applications. The first method is cloud-based, and the other is locally on a computer. Cloud-based applications are generally drag-and-drop and require no coding. Nonetheless, they are limited in features, providing only essential features for creating applications, and have monthly or yearly payment plans. Generally, this method is the easiest for creating AR applications. Table 3 shows some of the more popular current cloud-based platforms.

Table 2

A current listing of AR cloud-based development platforms

Platform name	Website	Payment plan
ARLoopa	arloopa.com	Monthly/Yearly
Assemblr	assemblrworld.com	Monthly/Yearly/Free*
Aumentaty	aumentaty.com	Free**
WebAR	mywebar.com	Yearly/Free*
Overly	overlapp.com	Monthly/Yearly/Free*
PlugXR	plugxr.com	Monthly/Yearly/Free***
Roar	theroar.io	Monthly/Yearly

Note. *The free version provides limited access to the tools and limited application views. **The company does not offer any other plans, and the user is limited to creating one application with one model. *** The free version provides limited application views.

The second method for creating AR applications is more complicated, requiring numerous software development tools (Tzima et al., 2019). It involves designing a user interface, generating easy-to-understand content, interactivity, and ease of use (Tuli & Mantri, 2020). Content deliverance is perhaps the most time-consuming since it requires developing all the content for the presentation (Tzima et al., 2019). Content deliverance is important since it seizes students' attention by stimulating their senses and keeping them focused on the presented information (Tulgar, 2019). The software tools needed for developing AR applications consist of modeling tools, marker production tools, engine tools, and software development kits (SDK) (Martlı & Ünlüsoy Dinçer, 2021).

Modeling tools are for creating 3D models of real-life objects to display on the learners' devices. As with most software tools, they come in various prices, configurations, and features. Tools previously used in other research articles and are currently available for modeling objects are Adobe Photoshop and Illustrator, Adobe Substance Modeler, Autodesk 3ds Max, Blender, Maxon Cinema 4D, Pixologic ZBrush, and SketchUp (Afnan et al., 2021; Akin & Uzun, 2022; Herpich et al., 2019; Köse & Güner-Yildiz, 2021; Martlı & Ünlüsoy, 2021; Mystakidis et al., 2021; Pellas et al., 2020; Shabane & Dehinbo, 2020). Of these listed modeling software programs, Blender is a widely used free modeling program with a steep learning curve (Kontseva et al., 2019). According to various researchers, Unity 3D is the most used engine for developing Android AR applications (Ablyaev et al., 2020; Gupta et al., 2023; Pellas et al., 2021). XCode is the only development tool for Apple devices (Herpich et al., 2019).

Unity 3D can interface with various plugins or SDKs to connect the application with the real world through object recognition. Object recognition can be marker-based, markerless-based, or 3D object tracking, and location-based recognition, also known as Geolocation (Afnan et al., 2021; Martlı & Ünlüsoy Dinçer, 2021; Mystakidis et al., 2021; Sarkar & Pillai, 2021; Tzima et al., 2019). Table 4 contains some currently available SDKs for AR development.

Table 3

A current listing of some SDKs for AR development

SDK	Usage Type	Platforms	Payment plans
Vuforia	Marker-based	iOS/Android/Windows	Monthly/Yearly/Free*
ARToolKit	Location-based	iOS/Android/Windows	Free
Google ARCore	Marker-based	Google Pixels/Samsung	Free
Apple ARKit	Marker-based	iOS	Free
MaxST	Marker-based	iOS/Android/Windows	Monthly/Yearly/Trial**
Wikitude	Marker-based	iOS/Android	Monthly/Yearly/Trial***

Note. *Free version provides a limited number of targets. **Trial is 30 days with accessibility to all features and development of one application. ***Trial is 45 days with accessibility to all features and a Wikitude watermark in the corner of the camera view.

Programming software is another tool required for developing interfaces, interactions, and trigger actions. Depending on the choice of development environment, it can be native to Android, iOS, Nintendo Wii, Windows, Windows Phone, MacOS, Xbox, or Web-based (Köse & Güner-Yildiz, 2021; Herpich et al., 2019). The most common programming software tools for AR development are C++, C#, Java, Javascript, and Kotlin (Afnan et al., 2021; Bazavan et al., 2021; Eang & Na-Songkhla, 2020; Mystakidis et al., 2021; Shabane & Dehinbo, 2020).

The Future of Augmented Reality

Since COVID-19, the world has gradually migrated to online education (Kuznetsova & Sos, 2020). Tóth et al. (2022) stated that the COVID-19 pandemic helped accelerate the adoption of online education worldwide. In a prior study, Parekh et al. (2020) discovered that COVID-19 helped to bring AR applications to mobile devices and led to greater social acceptance of this new technology. Because of discovering this new potential, the authors posited that AR is a futuristic technology that will change and reshape education and businesses. Wei et al. (2021) reached the same conclusion: the outbreak of COVID-19 helped give AR high visibility, and instructors were ready to effectuate AR as a teaching enhancement tool. For example, with the outbreak of COVID-19, students in Malaysia benefited from AR in learning abstract information through multimedia and increased their motivation to learn (Zambri & Kamaruzaman, 2020).

According to Tóth et al. (2022), the digital transformation of education is not all attributed to the COVID-19 pandemic. Transformation is a long-term factor in the gradual societal development that flows into education. The transformation affects how students learn, and their learning differs from past generations. In the classrooms, students (digital natives and immigrants) take snapshots of material written on the whiteboard with their mobile devices and use Google to search for information. Digital natives cannot learn effectively from an educational system not designed for them.

The children's and adolescents' perceptions and ways of processing information have changed dramatically. Information is readily available with the advent of the Internet, and they want it as soon as possible (Kuznetsova & Sos, 2020). Because of this 21st-century change in learning attitudes, instructors need to change and apply innovative educational technologies to adapt to the digital natives' learning characteristics. Smith et al. (2020) elaborated on how, by being born into digital technology, digital natives are skilled, literate, and proficient with various technologies. Due to their constant access to technology, their thought process differs from that of other generations, thus requiring an innovative change in their pedagogical formation. According to Sancho et al. (2022), digital natives' preference for learning with multimedia, gaming, social media, and stimulating interactions indicates that educators should consider using innovative technology in their courses. Tezer et al. (2019) pointed out that students are growing up in a rich multimedia environment, and integrating with technology is innate. These digital natives become rapidly disinterested in traditional learning methodologies because the lessons lack multimedia content, and they lose their motivation to learn. Fauziyyah (2020) discussed digital natives' different learning behaviors from past generations and how instructors using technology must be creative and innovative in developing lessons for digital natives to help keep their interest in the lesson. Tóth et al. (2022) stressed that traditional teaching methods must be modified to incorporate new technologies to motivate students.

Instructors have taught subjects such as medicine, chemistry, mathematics, physics, geography, biology, astronomy, and history using AR with positive affordances such as better learning outcomes, motivation, learner engagement, and positive attitudes (Tezer et al., 2019). The 2021 Educause Horizon Report (Pelletier et al., 2021) stated that digital natives prefer online materials over physical textbooks. The report also mentioned that San Diego State University had moved away from textbooks and now includes cutting-edge virtual resources and material. They are developing an open platform to make virtual resources available to all California State University System students. In addition, Hudson Valley Community College uses XR (extended reality) to create virtual field trips for students in the early childhood development curriculum. Wei et al. (2021) have stated that integrating technology, such as AR, multimedia, internet, and mobile devices, into education has transformed it into a more engaging, interactive, authentic, and joyful environment. Pelletier et al. (2021) forecasted that new technology usage would create demands for skilled instructional technology and design staff. Ergulec et al. (2022) stated that COVID-19 changed our educational system. Our future now includes distance learning as a permanent part of our lives, and there need to be courses that specifically teach instructional design for distance learning.

Antón-Sancho et al. (2022) mentioned that the U.S. Department of Education's Office of Educational Technology (USDOE-OET) recognizes the broad implications of technology in the classroom and encourages instructors to make technology-based lessons available to every student. Lampropoulos et al. (2022b) acknowledged that most of the general public is positively disposed to AR and VR in education. Vuță (2020) argued for integrating AR into the classrooms since many studies on AR-based learning environments have proven effective as an active learning method. Iqbal et al. (2022) determined that we are at the apex of exploring current challenges and potential usage of AR applications. The authors list five directions that AR education can take. The directions are through AR books, AR educational games, AR discovery-based learning, AR projects modeling real-world interactive objects, and AR projects for skill-based training. According to Parekh et al. (2020), there are a few challenges with everyone's acceptance of AR: the lack of AR design standards, security and privacy, and poor content quality.

The worldwide acceptance of AR as a plausible emergent technology for classrooms opens the doors for incorporating innovative approaches to education (Iqbal et al., 2022). Iqbal et al. (2022) proposed future research into remote learning in AR, kinesthetic learning in AR, real-time touchless hand interaction in AR, and machine learning for self-guided learning. According to Amara et al. (2021), changes caused by COVID-19 are here to stay, and Karacan and Akoğlu (2021) said AR is gaining momentum in education. In the Horizon Report, Brown et al. (2020) stated: "In order to stay relevant and sustainable, institutions will need to adjust their courses, curricula, and degree programs to meet learners' needs, as well as the demands of new industries and an evolving workforce" (p. 10).

Summary

After the COVID-19 pandemic, educators worldwide mobilized to bring their courses online quickly and sought solutions for integrating technology into their courses. Most teachers were willing to implement technology in their courses. The teachers had some familiarity with its usage, yet many did not have the skills or knowledge required for its implementation or development. It became apparent that AR and VR presented the best promising educational opportunities for innovative interactive applications. The instructors soon learned they needed specialized training to develop AR and VR technical content. Inclusively, instructional designers lack the formation to develop instruction using this technology. Instructors are prone to utilize the latest technology to interest students in the novelty and not integrate sound pedagogy.

Instructors need to assess which virtual technology is best for their courses. They need to know and differentiate when and how to use each technology. AR is a three-dimensional technology that displays digital information as an overlay on the learners' mobile devices. It combines a real-world environment with digital contextual information in text or multimedia. The learner receives immediate feedback when using AR. AR is considered an enhancement teaching tool.

VR is a three-dimensional virtual world where learners can explore three-dimensional visual simulations. The virtual world can be an imaginary universe created by a computer program or a replication of the real world. In a virtual world, a learner can experience the virtual environment visually, audibly, and on occasion, haptically. There are five classifications of VR: non-immersive, semi-immersive, immersive, augmented, and collaborative.

To implement AR or VR into the curriculum, instructors need technical training and knowledge of model frameworks tailored to technology usage. Various studies show a need for continuous professional development courses to secure technologically enhanced classroom curricula. However, various works of literature manifest ineffective training programs due to the lack of emphasis placed on the didactic behind technology use. Included in their training, educators need to understand how digital natives view and use technology. Additionally, constructivism, situated learning, and connectivism learning theories can guide the use of AR.

Studies show that ADDIE is the model framework most used for AR course development. The ASSURE model enhances the ADDIE model by incorporating media into the instruction. The Kirkpatrick framework is ideal for evaluating and analyzing the results of educational, training, and learning programs. The TPACK framework consists of three domains: content knowledge, pedagogical knowledge, and technology knowledge, and it has been proven successful in integrating technology into teaching.

Various educational disciplines use AR and VR technologies, such as mathematics, geometry, physics, geography, biology, astronomy, history, and chemistry. Instructors need specialized software tools to develop AR or VR applications to present content to learners in 2D or 3D format and to appeal to the learners' senses. There are two methods for creating AR applications – cloud-based and programmatically. Cloud-based is the simplest of the two, creating applications by dragging and dropping without coding. The second method requires various software programs to create 2D or 3D models, design user interfaces, create understandable content, design ease of use, and code interactivity.

Since COVID-19, the educational environment has changed. COVID-19 has helped propel the acceptance of AR into education. However, this digital transformation is not entirely attributed to the COVID-19 pandemic. Digital transformation has been a long-term, gradual societal process in development. COVID-19 accelerated the process, and many see AR as a futuristic technology that will change and reshape education. Because of this change in education, technological acceptance, and the need to adapt antiquated teaching methods to the learning characteristics of digital natives, educators are at the cusp of a new teaching renovation that will include innovative use of technology.

Changes brought on by COVID-19 are here to stay. The worldwide acceptance of AR has opened the doors for the inclusion of innovative approaches to education. Researchers need to conduct more research in AR remote learning, kinesthetic learning in AR, real-time touchless hand interaction in AR, and machine learning for self-guided learning. To continue the AR momentum, educators’ reservations about using AR need to be researched to find solutions that can quell and assuage their reservations.

Chapter 3: Research Method

The purpose of this chapter was to describe the design of this study, the research questions, participants and setting, testing instruments, procedures of data collection, and data analysis. The problem addressed in this qualitative hermeneutic phenomenological study was the limited understanding of why instructional designers are not using augmented reality (AR) as part of their course development practice. The purpose of this qualitative hermeneutic phenomenological study was to explore instructional designers' perceptions regarding the factors influencing their reluctance to incorporate AR into course designs. According to current research, studies in the evaluation and investigation of AR have been steadily increasing (Afnan et al., 2021; Maas et al., 2020; Sirohi et al., 2020; Tuli et al., 2021). Even though there is an increase in AR research, many educational institutions do not use augmented reality (Oliveira da Silva et al., 2019). I aimed to examine the acceptance level of AR by instructional designers and their willingness to use it and understand their reluctance to use it as a matter of practice.

Research Methodology and Design (Nature of the Study)

At the onset of this study, I considered two categories of research methods: empirical qualitative and empirical quantitative. According to Creswell (2013), qualitative uses well-established methodologies such as narrative/descriptive research, phenomenology, grounded theory, ethnography, and case study. Qualitative research explores and understands the meaning individuals attribute to a social, human, or cultural problem.

My study explicitly used a qualitative hermeneutic phenomenological methodology focused on using interviews. Hermeneutic phenomenological research is a methodology for studying the nature and meaning of lived experiences (Alaggia & Wang, 2020; VanLeeuwen et al., 2021). A more detailed description of hermeneutic phenomenology is described further down in this chapter. Generally, this research design was selected because it uncovers the meaning participants give to their experiences as they recount them. I selected qualitative research for this study because this type of research aimed to contextualize, interpret, and understand the participants' perspectives. Its qualitative characterization of intensive study, description of events, and interpretation of meanings are well-suited for phenomenological studies. Numerous studies apply phenomenological research to educational technology contexts dealing with students' interactions (VanLeeuwen et al., 2021; Vargas-Madriz, 2018; Yu & Watson, 2022). Schunk (1996) discussed how qualitative research is helpful for researchers interested in the perspectives of individuals and when there is a desire to explore new potential causal linkages.

The participants, and not the researchers, are the ones who emphasized the elements of experiences most relevant to them and declared how these experiences had impacted them. My study required that the participants reflect on their past experiences, thus supporting a deeper understanding of their historical involvement or understanding with AR and reinforcing the use of active interviewing. Holstein and Gubrium in Prout et al. (2020) described how active interviewing is the interconnection of the "how" and "what" of mutual experiences between the interviewer and the participants.

In addition to discussing qualitative research, Creswell (2013) also discussed how quantitative incorporates elements such as experiments using random assignments of subjects to treatment conditions under study. He also stated that it could also use less rigorous experiments such as quasi-experimental approaches. Quantitative research is a way of testing objective theories by studying the relationship between variables.

According to Seale et al. (2004), unlike a qualitative study that uses words and focuses on meanings, a quantitative research study uses numbers and is concerned with behavior.

Quantitative research can also generalize, whereas qualitative research cannot. Yilmaz (2021) defined quantitative research as using numerical research data and mathematically-based methods to explain phenomena, and for which its methods and procedures allow researchers to obtain a generalizable set of findings to present them succinctly. Privitera and Ahlgrim-Delzell (2019) mentioned that quantitative research uses scientific methods for recording observations as numerical data. It predicts and produces causal explanations. Findings from quantitative research discover behaviors and trends, but they do not explain why people think, feel, or act in specific ways.

All quantitative research methods considered for this study did not meet the standards necessary for appropriately researching the study's topic—for example, correlational research deals with analyzing relations between variables. As an illustration, Küçük et al. (2014) did correlational research to determine the relationships between attitude, cognitive load, and achievement in learning English using AR applications. Schunk (1996) stated that "…correlation research helps to clarify relations among variables [and its] findings often suggest directions for further research… A limitation of correlational research is that it cannot identify cause and effect" (p.12). The cause sought through this study was the problem of why many instructional designers are not using AR as a matter of practice. Therefore, the application of correlational research did not apply to this study.

All empirical qualitative approaches, except for the hermeneutic phenomenological methodology, also did not meet the necessary criteria for this study. For example, the narrative research methodology uses the experiences expressed in lived and told stories of individuals as data (Flick, 2014). Czarniawska (2004) defined it as the design in which "narrative is understood as a spoken or written text giving an account of an event/action or series of events/actions, chronologically connected" (p. 17). Using this method, the researcher can gather many different forms of data, such as through interviews, observations, documents, pictures, and other sources. Creswell (2013) discussed how narrative research can be the study of a phenomenon, such as end-of-life emotions, or a study method, such as procedures for analyzing stories. There are many types of narrative research methods that a researcher can implement. The following is a brief list of some narrative approaches used in research (Creswell, 2013):

- Autoethnography. This type of narrative is where study subjects write and record their personal stories.
- Biographical study. A narrative study where the researcher writes and records the experiences of the study subject's life.
- Life history. It is a narrative study where the subjects create stories to make sense of their lives, identities, and experiences.

Unlike a narrative study that reports on the stories of lived experiences of the individual or individuals under study, the phenomenological study focuses on describing what the subjects have in common as they experience a phenomenon (Creswell, 2013). Phenomenological studies focus on exploring a single phenomenon with a group of participants who have experienced the phenomenon. According to Creswell (2013), the group size varies from 3 to 15 participants, and "…the researcher brackets himself or herself out of the study by discussing personal experiences with the phenomenon" (p. 111). The researcher bracketing out does not entirely remove themselves from the study, but having personal experience with the phenomenon can set aside their experiences to focus on the experiences of the study participants. Creswell (2013) also stated that interviewing the participants is typically the data collection method used in phenomenological research.

The two main approaches to phenomenology are hermeneutic and transcendental (Creswell, 2013). According to dictionoary.com, hermeneutics comes from the Greek *hermēneutikós*, meaning interpreting. Van Manen (1990), in Creswell (2013), discussed how hermeneutical phenomenology is research-oriented toward interpreting life (hermeneutical) and lived experiences (phenomenology) (p. 112). Edmund Husserl was a well-known philosopher who significantly influenced known phenomenologists and founded the transcendental phenomenology movement (Eddles-Hirsch, 2015; Gros, 2017). Husserl defined transcendental phenomenology as "bracketing" out the outside world and focusing on the eidetic consciousness. Creswell (2013) discussed how by evoking intuition, imagination, and universal structures, the researcher obtains a picture of the experience.

The design of this study centered on topical questions to maximize understanding of lived AR experiences and participants' perceptions, which points to phenomenological research. The main drive behind this research design was the participants' thoughts, beliefs, and judgments. Van Manen (1990), in Creswell (2013), described the research as oriented toward lived experience (phenomenology) with an interpretation of the participants' lives (hermeneutics). Based on the problem statement and purpose of the study, two research questions supported this qualitative study:

RQ1. What are the perceptions and experiences of instructional designers in incorporating AR into course designs?

RQ2. What barriers, if any, have instructional designers experienced in working with AR?

The hermeneutic phenomenological research methodology, based on the principles of Van Manen (1990), was appropriate for the research topic because it brings forth all the personal experiences the instructional designers have with the phenomenon explored to coincide with the research questions. The rationale for using a hermeneutic approach made this study viable for understanding the experiences instructional designers have in AR use. The discovery of the experiences and essences of instructional designers' failure to adopt and incorporate AR into their course instruction was essential information for this research.

Population and Sample

This study required the participation of instructional designers and practitioners with at least three years of instructional design experience to understand their perceptions of AR and the barriers to its incorporation into instructional design learning instruction. The participants did not need to have designed and implemented AR learning experiences. The selection of experienced participants ensured the homogeneity of the group. To ensure maximum data saturation, I aimed to attain between 8 to 10 participants, with whom I had no prior relationship, for the in-depth individual interview (IDI) and draw 4 to 5 participants from the IDI for the focus group (Onwuegbuzie et al., 2009). However, I could only obtain seven participants for this study, which was sufficient for this study's data saturation. According to Francis et al. (2010), the concept of data saturation does not have a fixed number of participants, and it typically depends on factors such as the research question, the complexity of the topic, the diversity of the population, and the methods of data collection and analysis. Guest et al. (2017) recommended having more than one focus group, but due to different resource constraints, there was only one focus group in this study.

The aim was to pull the necessary number of participants from the Texas Digital Learning Association (TxDLA). I emailed a leading TxDLA organization officer soliciting help procuring participants for this study. I was not allowed direct access to the emails of TxDLA members; therefore, I had to seek assistance from one of the organization's members. Appendix E contains a copy of the recruitment email.

In case of failure to attain sufficient participants from TxDLA, a secondary plan was to recruit from social media platforms such as LinkedIn and Facebook using a recruitment process developed by Stewart et al. (2020) modified for this study. I did not implement the secondary plan. The process consisted of identifying the sources of potential participants, conducting an outreach by posting advertisements on social media home pages and possibly other moderator's blogs (with permission) explaining the study and requirements (See Appendix A), and creating the list of candidates who manifested an interest in participating in the study. Before the one-on-one interview, I contacted the candidates, provided more specific information, and answered any questions regarding the study process. Finally, to complete the enrollment, I emailed the future participants a consent letter for the future participants' consent (See Appendix D). After enrollment, I asked the participants to participate in a focus group.

LinkedIn is most interesting for recruitment due to the specialized formation of professional groups geared towards instructional designers and augmented reality. Some of the group titles on LinkedIn are Instructional Designers, Instructional Designers and Gamers, Druid Consultants- Instructional Designers, and Ohio Instructional Designers Association. Other groups that have instructional designers and an interest in technology are Immersive Instructional Designers, New Technology Innovations in Teaching, and Using Augmented and Virtual Reality in Corporate L&D. The list is not exhaustive but gives an idea of the immensity of groups on LinkedIn where soliciting participants for this study was possible.

Materials or Instrumentation

I looked into reliable instruments validated by researchers of studies related to the theories and methodologies selected in this study. A review of the principles of conducting hermeneutic phenomenological research using the instruments guided the development of the interview questions and the analysis process (Alsaigh & Coyne, 2021; Corby et al., 2020; Keshavarz, 2020; Stephenson et al., 2018). The reviewed studies brought reliability to the study's process because other researchers have used similar principles and questions. I supported the findings with data from participant quotations. Through this process, I added another level of validity. I invited subject matter reviewers to review the research questions to validate that the questions aligned with the study's goal.

Study Procedures

Before conducting this research study, I obtained approval from the National University's Institutional Review Board (IRB) to ensure that the treatment of the participants and the data collected for this study was appropriate, ethical, and secure. The approval included the participants' informed consent authorization form (see Appendix D). The consent form described the focus of this study, the participant's anonymity, and the collected data's security.

The focus group met virtually through Zoom video conferencing software. The research participants had internet connection, camera, and microphone access. In order to have a follow-up analysis of the focus group meeting, I made a video recording of the meeting.

All participants received a brief profile questionnaire before the meetings (focus group or IDI) and were assigned a pseudonym for filing their electronic data. The pseudonym was assigned to aid in preserving the anonymity of the participant. The questionnaire aimed to gather demographic information on the participants:

1. Get a brief profile on the instructional designers
    a. Specialty,
    b. Additional studies,
    c. Years as an instructional designer.

As stated in previous chapters, this study explored the perceptions and experiences of instructional designers about using AR. In addition, the study's results provided beneficial information regarding the acceptance levels of AR by instructional designers and their willingness to use it. Appendix B lists the research questions for the one-on-one interviews and the focus group session that helped understand and fulfill the aim of the study.

I collected data from two sources (interviews and a focus group). The participants filled out the brief profile survey before the one-on-one interviews. Interviews were valuable for gathering systematic information about the participants' feelings, perceptions, and opinions regarding the use of AR. The informality of the setting and the comfort level associated with working through technology led to a higher response rate in this form of data collection. The focus group was an asset for collecting more detailed information about personal experiences, insights, and opinions compared to the one-on-one interviews. However, the possibility existed that participants in the group environment would have been more reluctant to share experiences.

The Researcher's Role

The researcher is the primary instrument in a qualitative study (Xu & Storr, 2012; Yoon & Uliassi, 2022). The researchers' responsibility is to collect, analyze, and interpret all data. In this study, I had no relationship with any participants. My philosophical assumptions and interrelationship with the participants were an intricate part of the research. I guided the interviews following the proposed agenda (see Appendix C).

Data Analysis

In my study, I used two types of data gathering for triangulation. The first type was an in-depth individual interview, and the second was a focus group. Azad et al. (2021) described the IDI interview as the gold standard for understanding human beings and topics of limited knowledge. Santos et al. (2020) and Azad et al. (2021) described IDIs as flexible, allowing individual responsiveness. In the study by Santos et al. (2020), the authors described IDI interviews as a method for allowing spontaneity. In contrast to IDIs, focus groups provide the researcher with data from participants who interactively interchange comments. According to Fry et al. (2021), participants in a focus group can contribute different perspectives on the same topic to the research.

Creswell and Poth (2018) observed that triangulation in several models, data sources, or methods within the research study is a phenomenon. Triangulation involves judiciously reviewing the data collected through different approaches to achieve a more accurate and valid representation of participants' responses. Triangulation requires that the researcher use more than one method to gather data on the same topic so that the validity of the research is assured. As previously mentioned, this research study used interviews and participants from the interviews to form a focus group to achieve maximum saturation, triangulation, and credibility of this qualitative analysis.

I reviewed the recorded data collected from the interviews within 48 hours. I provided each participant with a one- to two-page interview transcript for feedback to ensure that I accurately transcribed the discussion. The correspondence included clarifying questions for the participant's feedback if necessary. I transcribed the audio recordings of the interviews using the

Adobe Speech-to-Text desktop application. As with other AI transcription engines, the transcribed audio was not 100% accurate and had to be manually corrected.

After receiving the feedback, I corrected and codified the transcriptions. The coding process entailed reviewing each line in the transcript multiple times and assigning a code to a word or a string of words related to the thought. Through this coding process, I reviewed each interview transcript in-depth and understood the participants' experiences and perceptions. I used the NVivo program to code keywords and create thematic groupings.

Assumptions

For my research study, I took into consideration two assumptions. For the first assumption, I assumed that each participant would act in good faith by responding truthfully and ethically. The second assumption was the belief that all participants possessed basic computer literacy knowledge to follow hyperlinks and input text into textboxes within the basic profile demographic online questionnaire.

Limitations

One of the limitations of this research involved sampling. Creswell (2012) stated that a "…researcher selects participants because they are willing and available to be studied" (p. 145), which is convenience sampling; therefore, it is a nonprobabilistic sampling approach. In addition, because of the small sampling size, the results of this study will not be generalizable to the whole population. Another limitation is recalling lived experiences. As time progresses, depending on the participant's interest in the topic, they may not fully recall their experience and convey an experience that did not happen. Therefore, I have no way of verifying the accuracy of their experiences. Even though the participants have experience in instructional design, and I did analyze the data they provided according to quality guidelines reaching maximum saturation, it was still not enough to provide a completely accurate understanding of the problem. A final limitation is that there is no guarantee that instructional designers who use or have used AR in their instructional designs volunteered to participate in the research study.

Delimitations

I chose not to specify any specific AR technology or brand so as not to limit the number of participants. Participation in the study was limited to only instructional designers and practitioners with at least three years of instructional design experience. Including non-experienced instructional designers would not have contributed professional knowledge to the study.

Ethical Assurances

I completed the Collaborative Institutional Training Initiative (CITI) program in October 2021 to ensure this research study aligned with high ethical standards. I sought approval from the National University's Institutional Review Board before initiating this study. Additionally, each participant received a consent letter (see Appendix D) stating that they must voluntarily agree to its terms detailing the study's parameters, research methodology, benefits and risks of participation, and their rights and anonymity. The participants were free to withdraw from the research at any time without retribution. The participant's name, IP address, or any other personal information was not collected while collecting the participants' brief profile information. Because of Google Forms' simplicity, I choose it as the program for collecting the participants' brief profile information. The data was stored as a password-protected .xlsx file and backed to a personal flash drive. I secured the flash drive in a locked desk filing drawer at my residence and shall keep it safely secured for three years. At the end of the three years, I will destroy the data by doing a full format on the flash drive.

Summary

The purpose of this qualitative hermeneutic phenomenological study was to explore instructional designers' perceptions and experiences regarding the factors influencing their reluctance to incorporate AR into course designs. This chapter outlines the methodology and design, population and sample, and the instrumentation for this research. It also presents the operational definitions, study procedures, data collection, analysis, assumptions, limitations, delimitations, and ethical assurances. I identified a recruitment process plan for obtaining volunteer participants and codifying their recorded audio transcripts to aid in producing the study findings.

Chapter 4: Findings

The problem addressed in this qualitative hermeneutic phenomenological study was the limited understanding of the perceptions of why instructional designers are not using augmented reality (AR) as part of their course development practice. Although AR is touted as a disruptive innovation in education, research exploring educators' perspectives using AR is still limited, focusing primarily on teachers rather than instructional designers (Akram et al., 2022; Mundy et al., 2019). A systematic review of AR in professional training contexts highlights the need for more studies focusing on instructional design aspects (Xu et al., 2022). According to current research, studies focusing on teachers evaluating and investigating AR have steadily increased (Afnan et al., 2021; Maas et al., 2020; Sirohi et al., 2020; Tuli et al., 2021). Even though there is an increase in AR research, many educational institutions do not use augmented reality (Oliveira da Silva et al., 2019).

The purpose of this qualitative hermeneutic phenomenological study was to explore instructional designers' perceptions regarding the factors influencing their reluctance to incorporate AR into course designs. The answers sought through this qualitative hermeneutic phenomenological study were to explore instructional designers' perceptions of using AR. The findings from the study revealed the acceptance level of AR by instructional designers and their willingness to use it, as well as their reluctance to use it as a matter of practice.

In this chapter, I discuss the trustworthiness of the data and the four pillars of trustworthiness: credibility, dependability, confirmability, and transferability. It follows with a discussion of the data-gathering method used to obtain the data and why it was chosen. I then discuss the data analysis procedures and how the study themes were selected. The chapter concludes with a discussion of the results in the raw format presented by the theme.

What follows is a brief introduction to the study, and the findings of the qualitative hermeneutic phenomenological study are based on the following two research questions:

RQ1. What are the perceptions and experiences of instructional designers in incorporating AR into course designs?

RQ2. What barriers, if any, have instructional designers experienced in working with AR?

This qualitative hermeneutic phenomenological study's data collection used two types of interviews: one-on-one and a focus group. Hermeneutic phenomenological research was selected because it is a methodology for studying the nature and meaning of lived experiences (Alaggia & Wang, 2020; VanLeeuwen et al., 2021). It uncovered the participants' lived experiences as they recounted them during the interviews. Qualitative research was used in this study because it helped contextualize, interpret, and understand the participants' perspectives on their use of AR.

The transcripts of each participant were analyzed for words, phrases, and common concepts to understand each participant's perspective. Each instance of similar words, phrases, and common concepts was gathered and placed into codes. The codes were categorized and then developed into themes. Six themes were developed from the analysis of the data from this study. The first theme encompassed the first research question on the perceptions and experiences of instructional designers. The remaining five themes covered the second research question about the barriers experienced in working with AR.

Trustworthiness of the Data

Qualitative research prioritizes rigor and truth, ensuring its trustworthiness and establishing a firm belief in the credibility and reliability of the qualitative findings. Creswell (2013) stated that qualitative research that is reliable and valid is considered rigorous.

Trustworthiness is a way of establishing research transparency and is crucial to the usefulness and integrity of the findings. Connelly (2016) explained that a trustworthy study generates trust in its data, interpretations, and interpretation process. The four pillars of trustworthiness referred to as "the Four Dimensions Criteria" by Lincoln and Guba (1986) are credibility, dependability, confirmability, and transferability (Enworo, 2023; Riazi et al., 2023).

Credibility concerns the confidence in a study that authentic or correct procedures and approaches were considered and eventually employed in collecting data, analyzing, and reporting the findings (Lincoln & Guba, 1986, cited in Enworo, 2023). Enworo (2023) stated that credibility is achieved through triangulation and member checks, thus ensuring that the results from the participants' perspective are valid and credible. In this study, I established credibility through member checking and triangulation.

In implementing member checking, I sent each participant a copy of their transcript for validation. The respondents' validation of their transcript strengthens the study's validity through the participants' feedback. Their feedback ruled out any misinterpretations of meanings and identified any plausible biases or misunderstandings I may have had (Flick, 2014; Grbich, 2013). Flick (2014) stated that triangulation takes several methodological or theoretical perspectives on an issue under study. For triangulation, I collected multiple data sources from various participants through individual interviews and a focus group. Triangulation helped to confirm and build upon evidence from other participants. New and contrary evidence emerged in multiple interviews and the focus group.

Dependability is obtaining the same results of a repeated study, providing that similar conditions are adhered to as closely as possible (Morse, 2015a, cited in Enworo, 2023). Enworo (2023) stated that in the dependability aspect of trustworthiness, the research process needs to be logical and transparent. Lincoln and Guba (1981), cited in Riazi et al. (2023), stated the existence of formidable ties between credibility and dependability. Dependability is attainable through credibility, member checks, triangulation, and an audit trail (Enwore, 2023). As in credibility, member checks foster collaboration between the participants and me and promote transparency. In my study, I established dependability through triangulation and the application of audit trails. The audit trail for this study consisted of documenting all research conversations, activities, and decisions. Creswell and Miller (2000) stated, "An audit trail is established by researchers documenting the inquiry process through journaling and memoing, keeping a research log of all activities, developing a data collection chronology, and recording data analysis procedures clearly" (p. 128). An auditor with a PhD in physics and terminal writing experience agreed that my study adhered to research design and documentation. My study includes specific details that were adhered to in the research design, implementation, and details of data collection. Adherence establishes the dependability of the qualitative data through assurance that the selected findings are consistent despite any changes within the research setting or participants during the data collection.

Confirmability refers to the extent to which the derived results from the participant's responses are reported objectively (Riazi et al., 2023) and are linked directly to the data. Including participants' quotes in the reporting data helps improve impartiality and establish validity and reliability (Cope, 2014; Riazi et al., 2023). Enworo (2023) stated that confirmability is obtained through triangulation and audit trail. In this study, I established confirmability by summarizing the content of each question that I asked during the in-depth interview and focus group. The approach showcased the overlapping categories without bias, plus all the comments heard. I included the participants' quotes in the report to demonstrate impartiality and establish validity and reliability. The individual interviews, the focus group, and the audit trail formed the basis of the triangulation, thereby providing confirmability.

Transferability pertains to the degree to which the research outcomes can be applied to similar contexts, people, groups, and settings (Ahmed, 2024; Cope, 2014; Zia Ul Haq et al., 2023). The transferability concerns detailed accounts of the context, participants, methods, and transparency in the research that would enable the reader to evaluate the similarities and determine if the findings apply or are transferable to the readers' context (Ahmed, 2024; Connelly, 2016; Subedi, 2021; Zia Ul Haq et al., 2023). The transferability criteria are met when the results have meaning to individuals not participating in the study, and they can associate the results with their own experiences. In this study, I established transferability by gathering and providing the information listed in the following two tables. Table 5 describes the years and experiences the participants have worked as instructional designers in working with AR.

Table 4

Instructional Design Experience

Participant	Years Working as an Instructional Designer	Experience Working with AR
P1	8	Store robbery safety simulation.
P2	26+	Google beta tester; Incorporated AR apps in education K-12 (art, history, science, math).
P3	7	GeoGebra in higher-ed.
P4	7	Military tactical training.
P5	25+	Social training courses.
P6	12	None.
P7	8+	None.

Table 6 provides additional information to help reinforce transference. The table provides the number of study participants and the data collection method applied – individual interview or focus group. The table also lists the questions asked in both collection methods and the period over which data collection occurred.

Table 5

Transference Information

Number of Participants	Data Collection Methods	Questions Asked in Both Methods	Data Collections Period
7	Individual Interviews	1) What are your perceptions and experiences in incorporating AR into course designs?	August – October 2023
3	Focus Group	2) What barriers, if any, have you experienced in working with AR?	October 2023

Data Gathering Method

Before conducting this research study, I obtained approval from the National University's Institutional Review Board (IRB) to ensure that the treatment of the participants and the data collected for this study was appropriate, ethical, and secure. The approval included the participants' informed consent authorization form. The consent form described the focus of this study, the participant's anonymity, and the collected data's security. The consent form delineated the study questions and process. It also explained that the participant could participate in the study voluntarily or refuse to participate and withdraw from the study at any time.

I designed the research questions so the participants could express their thoughts and experiences in working with AR. Academic advisors and staff scrutinized the study as auditors of the data collection and analysis and field testers for credibility and dependability of the interview questions. The advisors and staff provided valuable feedback, helping me revise and ameliorate the study.

I recruited the participants for the study through a digital learning organization. I sent a consent letter to all participants interested in volunteering for the study. Before the interviews, I asked if they had read the letter and agreed with its terms. Because I could not access the members of the organization directly, I provided a recruitment email copy for distribution to the director of the organization, who then published the email letter to all the organization's members.

Eleven individuals responded to the initial request for participation in the study. One individual was disqualified from participating because the individual needed to meet the time requirement for working as an instructional designer. I sent follow-up emails requesting a time when we could meet for a Zoom virtual meeting. Three individuals never responded to the follow-up emails or subsequent reminders. The interviews of seven individuals contribute to the results of this study. All seven individuals agreed to participate in the focus group. However, in the end, only three participants attended the focus group.

All sessions were video recorded and saved in MP4 file format on an internal hard drive and a USB device. I encouraged honesty from the participants during the interviews. After analysis and transcription of the data, the file on the hard drive was eliminated and scrubbed clean using Wise Care 365 File Shredder. I transcribed the MP4 files by using Adobe Premier Pro 2023. The transcribed files were personally verified and adjusted where they needed transcription correction. I saved the transcribed files on the USB drive as text files. I eliminated all references to the participants' names in the transcripts. Designators P1 through P7 replaced all participants' names.

Data Analysis Procedures

I employed a semi-structured questionnaire in the individual interviews and the focus group as data collection methods. I used thematic analysis (TA) to identify common themes. I could locate words, phrases, and common concepts through the analysis and multiple re-readings of the transcripts. The "perception codes" generated few but consistent categories. The "barrier codes" yielded categories from which I could derive five themes. During the interviews and the focus session, I remained a third-party observer of the participants' dialog and attitudes.

Before the data can be analyzed, Denscombe (2014) states that the qualitative data gathered needs to be prepared and organized. Denscombe (2014) says that protecting the original data from corruption or damage is essential and good practice. He recommends storing audio recordings and transcripts separately from "working copies" since tampering with the original copies can detrimentally affect the research project. Following this recommendation, all original audio recordings and transcripts are stored in a separate USB drive and placed in a different location from my office space.

Thematic Analysis

With its broad philosophy, qualitative research allows for different approaches to analyzing data. Such flexibility allows for multiple analyses of the phenomenon and gradual progress toward comprehensive representations. Two separate approaches to qualitative data are thematic and content analysis. These two terms are often used interchangeably because of their similarities (Clark & Braun, 2020; Vears & Gillam, 2022).

Content analysis is a systematic coding and categorizing approach used to describe and understand the phenomenon under investigation that is directly relevant to practice. The researcher will seek a practical answer or application of the findings. The interview questions will be specific and direct rather than broad (Vears & Gillam, 2022). Vears and Gillam (2022) suggested that thematic analysis, the best-known form for analyzing interview transcripts, be used when there is scarce information about the area of interest. Braun and Clarke (2006) defined thematic analysis as “a method for identifying, analyzing and reporting patterns (themes) within data.” (p. 79). Thematic analysis helps contribute to the theoretical literature by seeking answers beyond the situation’s particulars.

I used NVivo 20©, a qualitative data analysis program, to analyze transcribed data from the seven participants and those in the focus group. I followed Braun and Clarke’s (2006) six-step guide to analyze, identify, and report patterns (themes) found within the data. Table 6 lists the six phases of thematic analysis.

Table 6

Six Phases of Thematic Analysis

Step	Title	Description
1	Familiarization with the data.	If necessary, transcribe the data. Read and re-read the data while jotting down any initial ideas.
2	Generate initial codes.	Code any noteworthy features of the data systematically across the entire data set and group data relevant to each code.
3	Search for themes.	Collect codes into potential themes and group the data relevant to each theme.
4	Review the themes.	Verify that the themes work with the coded extracts (Level 1) and the entire data set (Level 2), producing a thematic map of the analysis.
5	Define and name the themes.	Iteratively analyze each theme to refine the specifics of each one and gather the overall story told by each to generate clear definitions and names for each theme.
6	Produce the report.	Select vivid, compelling extract examples and produce a final analysis of the selected examples relating to the research question and literature. Produce a scholarly report of the study.

Results

Many studies previously explored the use of AR applications in education, as well as the views and experiences of teachers (Akçayır & Akçayır, 2017; Arici et al., 2021; Belda-Medina & Calvo-Ferrer, 2022; Garzón et al., 2019; Saltan, & Arslan, 2017; Tzima et al., 2019). There was a gap in studies analyzing the instructional designers' perceptions of the use of AR. The results presented in this study are the views and experiences of instructional designers.

Seven instructional designers with more than three years of experience participated in this study through a one-on-one Zoom interview, and three of the seven individually interviewed instructional designers participated in a focus group. Regarding involvement in AR projects, five participants have worked directly on AR projects. One worked indirectly as a Quality Assurance evaluator for AR tools, and one has never worked directly or indirectly on any AR project. Hennink and Kaiser (2022) and Subedi (2021) provided the guidelines for this study's data saturation requirements. They defined data saturation as the point at which data provides little or no relevant new codes and provides no further understanding or contribution to the study. The focus group meeting, conducted after the individual interviews, provided no new codes, thus fulfilling the data saturation requirement.

Table 8 lists the research questions that I asked each participant. Table 8 also lists the themes and sub-themes drawn from the answers to the corresponding questions. There will be themes where some sub-themes overlap. RQ1 has two overlapping sub-themes: Advantages and preferences, and Application and usage in education and the job market. For RQ2, the overlapping sub-themes are (1) Device Usage – Lack of IT structure with Money – Cost, and (2) Device Usage – Technical skills with Training Time – Challenge getting people to understand the technology (See Table 7). Sub-theme Training Time – Time also overlaps various sub-themes due to the training needed for content creation, curriculum alignment, and technical skills required to operate the devices, develop the programs, and build the IT structure.

Table 7

Themes and Research Questions

Research Questions	Themes and Subthemes
RQ1: What are your perceptions and experiences in incorporating AR into course designs?	Theme 1: Usage and Applications - Advantages, preferences, and challenges of using AR • Advantages and preferences. • Application and usage in education and the job market. • Challenges.
RQ2: What barriers, if any, have you experienced in working with AR?	Theme 2. Device Usage • Ease of use. • Equal access. • Lack of IT structure. • Not practical. • Technical difficulties. • Technical skills. Theme 3.: Lack of Understanding • Conception. • Content. • Curriculum alignment. • Do not understand the technology. • Faculty resistance. • Management buy-in. Theme 4: Logistics Theme 5: Money • Budget. • Building IT structure. • Cost. Theme 6: Training Time • Challenge getting people to understand the technology. • Learning Curve and Professional Development. • Technical skills. • Time.

Research Question 1

The first research question in this study was: What are the perceptions and experiences of instructional designers in incorporating AR into course designs? A single theme with three sub-themes emerged to answer this question. The theme concerns the usage and applications of AR along with its advantages, preferences, and challenges. Most instructional designers perceived AR as a valuable tool for various applications. At the same time, some manifest that AR is a costly, underused tool with no direct job applications.

The theme also provides insight into how instructional designers perceive AR as a tool with many uses, within a reasonable budget compared to virtual reality (VR), and positivism on overcoming any barriers to its use and implementation. The theme highlights the belief that AR has a promising future. The discussion of this theme follows and contains quotes from the data. When referencing participants in the following discussions, the designations P1 through P7 refer to participants one through seven.

Theme 1. Usage and Applications - Advantages, Preferences, and Challenges of Using AR.

The participants in this study have highlighted AR’s immersive nature as a significant advantage, enhancing learning experiences and operational efficiency. A notable preference for AR over VR and mixed reality (MR) stems from its accessibility and the ability to overlay digital information in the real world, which many find less disorienting and more applicable to real-life scenarios. However, technological barriers and a lack of widespread AR adoption in curricula and industry practices have hindered AR’s acceptance.

Advantages and preferences. Some instructional designers feel AR will be more successful than VR. P3 stated, “I feel like if there’s one tool that’s going to be successful, I think right now it will be AR over VR.” P7 concurred with P3, stating, “I will agree with you on that. We definitely like AR. Our faculty likes it more than the HoloLens, specifically over VR.”

Most participants commented positively on the usefulness of AR as a learning tool. P2 gave some AR examples: “The ability to do simulations with AR and to pull up things like the human body or the interior workings of an engine. That kind of thing has value.” P3 commented on how the students use it; their overall comment is, “It’s been fun.” P3 believes in using AR at the High School: “I think augmented reality is a great tool for my High School.” P3 also gave examples: “Students could learn how to change the oil on a car,” and “the nursing resources could learn nursing from where they are.” P2 believes that colleges would be susceptible to AR’s use at the college level: “I think colleges are more open to it because they do tie in so much with the workforce.” P3 references AR’s use in learning:

> It is a huge collaborative piece that’s such a cool opportunity for learning. And I think that it provides an engagement that can’t be experienced any other way. I can see different ways of using it that would be really valuable to a student and to a learning experience that you may not be afforded otherwise.

Participant 4: “I think that it provides an engagement that can’t be experienced any other way.” P5 contributed other examples for AR in a learning environment: “I think augmented reality would be phenomenal for your classes, scavenger hunts, or for things like safety classes where they’re having to find where all the issues are.” P7 mentioned using Apple Glasses for learning: “You could put on the Apple Glasses and learn things that way.”

Most participants thought highly of AR. P1 stated, “It’s where the future is going.” P3 gave a positive review, “I think it’s a cool opportunity.” Participant 6 has been very satisfied with the buy-in at all levels of management: “Definitely faculty buy-in, leadership buy-in, buy-in on the highest levels has been fantastic.” P7 uses AR in the classroom and receives positive feedback from the students: “One of the technologies as far as AR that we have been using is the

HoloLens, and that has been doing really well so far. The initial feedback we have is very positive," and P7 continues, "You could still interact with your physical world and see digital overlays. It was it was impressive." P5 has worked on a safety project using AR and thinks that AR "would be phenomenal for that kind of stuff" in teaching children safety procedures.

Application and usages in education and the job market.

Still, there were mixed comments as to the application of AR in the job market. Participant 7 believes there are no direct job applications for AR: "There's even a cost, a pretty steep cost, especially since I don't see any direct applications for jobs at this time." P7 believes that blue-collar jobs or industrial training spaces are the closest job applications where AR can be applied: "I could see some applications there where you could superimpose the template onto where you need it to be. I think especially in jobs that you require people, you know, more blue-collar jobs where you're actually handling real space. Space for training materials in real life." Participant 6 has worked with AR but has not found a beneficial use for it: "We're still looking for good uses for that." "We've looked into the Adobe Aero, but the practicality of using that, we just, it just hasn't tracked yet."

Other participants stated there are many ways to apply AR in a learning environment. Some representative comments are as follows: P3 said, "I think it has limitless opportunities," and P1 stated, "I find it hard-pressed to find a project that couldn't use it in some way." P1 and P6 both used HoloLens as an educational tool. P1 used it to simulate store robberies and store safety. P6 used it as a tool to teach math.

Challenges. There are challenges in getting AR accepted as a learning tool because it is unknown or underdeveloped. Participant 4 feels that AR is an underused tool because "it's not a known process of learning." P2 has worked with AR but feels it is underdeveloped and underused. P2 sees how ARs' use is more prominent but sees that the market has failed to catch on:

> It's a technology that is incredibly underdeveloped and underused. As a teaching, learning, and creativity tool, it's an amazing resource, and both AR and VR, I think, are underused in the education market. I think that's because the commercial market hasn't catered to that. They're looking at games and that sort of thing, and they're having a hard time getting it, starting to catch on. Some waterparks are using it, and you're starting to see more of it in people's homes.

P2 does not see any organization investing in AR "if it doesn't improve test scores, unfortunately in K-12, or increase completions of programs and hiring of jobs." Many participants believe that implementing AR would be a challenge due to the steep entry cost. P3 exemplifies most comments of other participants, "But, I think the hurdles right now are too great. The cost of entry is ridiculous." Still, a participant in the Focus Group stated that people do not want to invest in the technology since such few people have embraced it. However, the participant continued,

> I think the military usually is the lead in situations like this, making it more cost-efficient over time and breaking down the walls of things [like] the cost of the headsets, the access to bandwidth, and the training that go that needs to be in place for the teachers to implement something like this.

All participants interviewed in this research believe there are many barriers to overcome before AR can be widely accepted. Regarding the barriers preventing AR from being entirely accepted, P2 stated, "There are a lot of barriers out there, but I don't think any of them are insurmountable." P7 opinioned how, by doing group collaboration between organizations, they might be able to get AR products: “We’re also looking into to address some of the pricing in collaborating and doing group funding between organizations is what we’re looking at like if everyone pitches in, could we get this product collectively?”

Research Question 2

The second research question in this study was: What barriers, if any, have instructional designers experienced in working with AR? Five themes emerged to answer this question. Theme 1 concerns the use of the devices and contains six sub-themes. The six sub-themes cover the topics of the devices’ ease of use, equal access time, lack of IT structure support, lack of device practicality, various technical difficulties, and lacking technical skills.

Theme 2 shows how a lack of understanding of AR technology becomes an acceptance barrier. Theme 2 contains six sub-themes. The six sub-themes cover the topics of conception, content, curriculum alignment, faculty resistance, lack of understanding, and management buy-in. Theme 3 addresses the topic of logistics. Theme 4 provides information on money being a barrier to AR adoption. Theme 4 contains three sub-themes: budget, cost, and IT structure. Theme 5 pertains to training, and it has four sub-themes: lack of understanding, technical skills, time, and training.

Theme 2. Device Usage.

The participants in this study voiced their views on device usage barriers to adopting AR in educational settings. Challenges range from the practicality of AR headgear and object recognition to disparities in technology access among students. Additionally, infrastructural limitations such as inadequate internet bandwidth and lack of device management systems in schools pose substantial hurdles. Participants also highlighted the impracticality of AR for situational learning, technical issues with system overload and security, and the steep learning curve associated with developing technical skills for AR.

Ease of use. Participant 3 provided examples of difficulties the students encountered when using the AR headgear: "Putting the headgear on a lot of the students with different hairstyles became a big hurdle … because their hair doesn't fit in it, their heads bigger, and they have to resize it, their foreheads smaller," and "[Students with] darker toned skin like pigments cannot grasp or move the tools very well in the augmented environment." P5 summarizes the AR barriers: "If it's not used right, it'll be a waste. Users will think it's a waste of time. Learners will think it's a waste. Um, you have to be careful with how to use it."

Equal access. The concern among the participants is that not all students will have equal access to this type of technology. P3 stated, "It's not fair to give one student this opportunity and let all the rest of them watch them." P2 said, "The assumption is that all students have equality or equity in terms of access to those sorts of things."

Lack of IT structure. Augmented reality devices require access to the Internet and a decent bandwidth. Not having these two items is a concern to the participants. P2 stated that one of the problems encountered in working with AR was: "Wi-Fi access. Good Wi-Fi that can handle the AR access to devices. "P3 also experienced the same issues: "We had huge Wi-Fi challenges." P3 also brought up the issue of having the structure in place for managing the devices: "You've got multiple devices, you've got how do you [*sic*], you know, charging them, keeping them safe so they're not stolen" and "the access to bandwidth and the training that needs to be in place." Someone in the focus group said "access points and having enough of them" was a barrier to implementing AR into the school. P3 also mentioned a privacy concern where the school would have to open up a port to allow access to the resources, "The school may not have wanted to open the port. That would allow us to access the resources through the Wi-Fi. This is a challenge in every school district because they are very protective of the data that is coming in and out."

Not practical. Some participants brought up the issue of AR not being a helpful tool for situational training. An example was given by P4 in which the content provided could not foresee all possible situations in the field of combat.: "Tests has shown that right now for soldiers, it is not there yet, for the most part, because they're more elements other than what can be simulated or placed into augmented reality." P3 stated, "I think one of the other barriers right now is there is finding opportunities to build something practical."

Technical difficulties. Participants reported various technical challenges when working with AR devices. P3 reported, "A lot of the issues with connectedness within a school environment as exists in Israel when it comes to AR... [and] having too many devices weigh down the system and cause issues." For security reasons, P7 had to find a workaround when working with AR to pass data to the LMS: "You can turn off the Wi-Fi if everything's built. We were just very intentional about it, not having to connect to anything. So, we can't pass, for example, data completion data to our LMS." P3 discussed how having 5 people on the system would weigh it down, "There would be four people in there. Plus, typically there was a person in the room that was monitoring and just recording what was going on in the room from their heads. And so that could really quickly weigh down the system and cause issues." P6 commented on having many "I.T. issues" but did not elaborate beyond that statement.

Technical skills. Participants reported AR as too "techie" and having a high learning curve. P4 stated, "it's a learning curve of the instructors or teachers to implement that to their curriculum or into their training sessions." P5 said that if P5 had not had an interest in learning about it, P5 would not have known about it:

> I had to teach myself because there were no classes for me to learn from. So that's how I found the Microsoft program. I was [*sic*] I went to their conference where they talked about it, and then I had to go and teach myself that. So that was one barrier. So if I wasn't willing to do that, I wouldn't know about it.

P4 also mentioned, "I'm an social designer at the university level. They do not like it. Not in the least. So it's a little bit too techie for them." P3 also worked with META and found that META had no clue how to incorporate AR into the classroom:

> It was META that was actually um requesting the information. And, you know, I found it funny that, you know, they they [*sic*] really have no idea how to put this into the classroom or to get the the teachers [*sic*] to embrace this without, you know, forcing all the infrastructure changes and and [*sic*] I know that that's that's [*sic*] going to be like the biggest barrier to entry for anyone wanting to do that.

P3 shared how the school's district lacked the necessary hardware. P3's team had to provide the hardware needed to work with AR. "When we were in the school district, we decided to use our own boxes to get around that. So, we had, we brought our own Wi-Fi access points and we use those for the activities." P5 mentioned how most instructors at the college do not like AR, "It's a little bit too techie for them…They do not like it. Not in the least."

Theme 3. Lack of Understanding.

A common misconception is viewing AR as merely a gaming platform rather than a valuable educational tool. The scarcity of high-quality academic content and uncertainty about integrating AR into existing curricula further compound the educators' understanding.

Additionally, there is a lack of clarity regarding AR's capabilities and its distinction from VR or MR. Resistance from faculty—from fears of obsolescence among veteran educators and time constraints for newer teachers—further impedes the adoption of AR. Lastly, securing buy-in from upper management remains a significant hurdle to embracing AR technology in education.

Conception. Participants believed that the conception of others is that AR is considered more a game than something valuable for education. P2 remarked, "Conception by leadership that this is play rather than educational." P5 commented, "If it's not used right, it'll be a waste. Users will think it's a waste of time. Learners will think it's a waste … Getting people to go beyond the games and get into the educational piece of that." P2 also remarked how important it is to conceptualize a result: "If we don't do a tie into the end result, if it doesn't improve test scores, unfortunately in K-12 or increase completions of programs and hiring of jobs, it's not going to be a money investment for anybody." P7 believes that instructors "think more, much more VR than they think AR."

Content. The lack of access to quality AR content concerned the participants. P2 is concerned that there is insufficient "access to quality content" to warrant using AR. P2 discussed a quality application they used in a school environment to study a Vincent Van Gogh painting, but other applications were sub-par. P2 shared:

> We compared the work of two different works by Vincent Van Gogh. Being able to use the augmented reality drill all the way down to the brushstrokes, right? That was a really quality app. But then we've tried other apps on the Merge Cube, and a couple of other devices that were just not very good quality, very basic 3D rendering, right. Not, not a lot of detail.

Continuing with the discussion of the lack of available quality content for AR, someone in the focus group said, “I think that as far as learning goes, there’s just not much out there.” And still another comment from the focus group:

> One of the other barriers right now, is there, is finding opportunities to build something worthwhile. It’s so costly for companies to invest in building resources for this medium that I think that, as far as learning goes, there’s just not much out there.

P3 stated, “I think [AR] has limitless opportunities. It’s just the creation of the resources that needs to happen. It’s so costly for companies to invest in building resources for this medium that I … there’s just not much out there.” P5 remarked, “It is very hard to get anybody on board with augmented reality for the sheer fact that you have to have the right software.” P2 mentioned that we need to get “people to go beyond the games and get into the educational piece of that.”

Curriculum alignment. The participants mentioned not having the skills necessary to implement AR into the curriculum. P2 succinctly mentioned the barrier of the “alignment with curriculum.” P4 stated, “I think one thing is that it’s a learning curve for the instructors or teachers to implement that to their curriculum.” P7 discussed “those challenges like getting it embedded into the curriculum, you know, training, training faculty, the tools and then .. getting students trained on how to use it.” P7 added, “Get everyone trained. Get it into your curriculum before you make that purchase.”

Do not understand the technology. Most participants cited a lack of understanding of the technology as a barrier. The instructors cannot incorporate technology into the curriculum without the necessary expertise. A comment from P7 in the focus group previously mentioned, “A challenge getting it embedded into the curriculum,” and “[META] really have no idea how to put this into the classroom or to get the teachers to embrace this without, you know, forcing all the infrastructure changes." P3 stated, "You've got [to get] the teacher to understand how to use them to begin with. That's a big barrier." P4 shared, "People don't really understand it until they are in it. So I think one of the barriers I see it's not a known process of learning." Participant P5 realizes that many people confuse AR with VR. At the onset of the interview, P5 asked, "When you call an augmented reality, you're not confusing it with virtual reality, right? Sometimes, people interchange those." P6 shared another point of view, "Some people just don't understand how they can use it as a teaching tool. They see it as a toy and not really a teaching tool." From an economic point of view, P5 stated, "It's having to educate people that augmented reality is a thing, and it's affordable."

Faculty resistance. There are two kinds of resistance. One is from the older faculty who are already overwhelmed by the new tools they must learn to use and those who fear the tool will replace them. For the first type, a member in the focus group shared, "The older teachers they're not going to want to have this type of technology so easily simply because there's a learning curve now and they have so many more tools that the school districts are getting for them." Another commented, "[A teacher will think] here is another tool that I got to learn, and also be an expert, enough to teach my kids." The same person continued, "They're overwhelmed with tools." P5 stated, "I'm a social designer at the university level. They do not like it [AR]. Not in the least. Getting people on board with it … is my uphill battle."

The other type of resistance is described by P6, "Some of them are hesitant, they think that it's going to replace them." The tools are too futuristic. Comments from the focus group include, "Something like this is highly futuristic" and "Add another tool that is actually on the higher end of technology."

Management buy-in. There were five comments regarding management buy-in. The following represents all of them: P1, "[Barrier] Getting the buy-in," P6, "definitely faculty buy-in, leadership buy-in, buy-in on the highest levels." P7 shared, "I think there's some fascinating opportunities that you have to then convince the upper decision-makers that it's worth it, which is always a challenge when you're suggesting something new."

Theme 4. Logistics.

There were a few concerns regarding logistics. P7 mentioned, "Everyone's excited for it, but then making it like a reality is, you know, there's there's logistical issues there and it does take time." P3 added, "People don't want to invest in it and people don't want to invest in it because so few people have embraced it. And the training that go that needs to be in place for the teachers to implement something like this." P3 provided some examples of logistical concerns in addition to the required training: "You've got multiple devices, you've got how do you [*sic*], you know, charging them, keeping them safe so they're not stolen."

Theme 5. Money.

Participants voiced concerns regarding the financial barriers to the adoption of AR. Key issues include securing budget approval from upper management, the substantial investment required for the necessary IT infrastructure, and the costs associated with software design, hardware procurement, and content development. The participants highlight the need for a comprehensive strategy to address the economic implications of integrating AR into educational settings.

Budget. A couple of participants mentioned budget as being a barrier. P1 stated, "Getting buy-in budget." P6 said, "Money would be, probably, our next barrier as we, as we, start to implement more."

Building IT structure. A few participants mentioned the cost of implementing the IT structure as a barrier. P3 discussed how "forcing all the infrastructure changes, and, and I know that, that's, that's [*sic*] going to be like the biggest barrier to entry for anyone wanting to do that [implement AR]" P2 and P3 stated that the challenges of accessing good Wi-Fi would be a barrier. P2 commented, "Access to Wi-Fi, good Wi-Fi that can handle the AR access to devices."

Cost. The cost of implementing this technology is a significant concern for most of the participants. P3 stated, "It's so costly for companies to invest in building resources for this medium" and "I think the price structure is makes it not doable for K-12" P2 succinctly stated, "It's too expensive" P5 mentioned a fear: "There's such a fear of it costing too much" P7 added, "It's a pretty steep cost in, in equipment and software" and concluded with "for all the reasons you guys have mentioned like that, that price point is barrier."

Theme 6. Training Time.

The time required for training presents distinct challenges, as the participants in this research reveal. Key among these is the steep learning curve associated with understanding and utilizing AR technology, necessitating significant training for instructors, particularly those less familiar with digital tools. Additionally, developing technical skills is imperative for both the IT department and educators, and it forms a crucial part of ongoing professional development. However, time constraints pose a substantial barrier, with faculty members already burdened with existing responsibilities, making the integration of AR a complex endeavor.

Challenge getting people to understand the technology. An instructor who does not know or understand the technology will need training. Some of the comments were previously mentioned in Theme 3 but are worth mentioning again. P6 stated, "Some people just don't they don't understand how they can use it as a teaching tool. They, they see it as a toy and not really a teaching tool" P5 mentioned that people confuse AR with VR: "When you call an augmented reality, you're not confusing it with virtual reality, right? Sometimes people interchange those" P5 discussed having to educate people on using AR technology: "It's having to educate people that augmented reality is a thing and it's affordable, but to getting them to understand how augmented reality can work in their courses."

Learning curve and professional development. People from the IT department to the instructors must develop technical skills to incorporate AR technology. P1 discussed how "not having everything you need in-house" was a barrier. The following is P5's experience:

> I had to teach myself because there were no classes for me to learn from. So that's how I found the Microsoft program. I was I went to their conference where they talked about it, and then I had to go and teach myself that. So that was one barrier. So if I wasn't willing to do that, I wouldn't know about it. So to put even more technology into it, only my younger instructors are willing to do that because not only do I have to teach them this is what could be in your course. I have to teach them how to do it because I only designed the course for one sitting. Then they have to maintain it.

Furthermore, P3 shared through experience how technical skills are needed: "So when we were at the school district, we had, we decided to use our own boxes to get around that. So we had, we brought our own Wi-Fi access points and we, we use those for the activities."

Technical skills. Almost all participants discussed how training was a significant barrier. I have previously mentioned many points throughout this chapter referring to training, so I will not include them here. P7 recommended, "Get everyone trained. Get it into your curriculum before you make that purchase." P7 also discussed the challenges personally experienced: "We face those challenges like getting it embedded into the curriculum, you know, training, training faculty, the tools and then, you know, getting students trained on how to use it." P4 mentioned the reason for the learning resistance: "You know, the older teachers that they're, that they're not going to want to have this type of technology so easily simply because there's a learning curve."

Time. A few participants mentioned time as a barrier for AR acceptance. P5 said, "Time is a huge barrier when it comes to augmented reality." P5 continued, "Teaching them all those components, sometimes I don't have enough time to do all of that. Sometimes, I barely have enough time just to create a regular course that's slightly interactive." P7 stated, "It does take time. I've been kind of, as a general rule of thumb, what I've been telling faculty before they jump into anything XR is it takes a year to do implementation." P4 mentioned, "And I think one thing is, is that it's a learning curve of the instructors or teachers to implement that to their curriculum or into their training sessions."

Evaluation of the Findings

RQ1. *What Are the Perceptions and Experiences in Incorporating AR Into Course Designs?*

Most of the comments discussed the possible uses of AR in education and the job market (See Table F1). The perceptions of the instructional designers were favorable when applying AR to the fields of education in K-12 and in healthcare training. However, they discussed that the use of AR for education in an environment, such as in the military, was limited because of its need to account for all possible scenarios.

The experiences and ideas expressed by the participants in this study align with those found in other studies presented in the literature review. The participants shared their AR experiences working with their students in educational disciplines, such as art, history, science, and math. Most literature dealt with science disciplines, such as those shared by Huang et al. (2021), Tezer et al. (2019), and Hidayat and Wardat (2024), where they discussed ARs' use in educational disciplines, such as mathematics, geometry, geography, and chemistry. There were few literature articles dealing with the use of AR in the art and history disciplines. Those articles suggested using AR in those disciplines (Isa, 2023; Tzima et al., 2019) as a kinesthetic learning method. Bridging the gap between various disciplines, integrating AR in education resonates with the scientific focus found in the literature and extends to kinesthetic learning across subjects.

Some participants in this study commented that most students are kinesthetic learners, and by using AR, the students could learn by moving and manipulating objects with their hands. The statement aligns with Amara et al. (2021), who stated that using AR and VR increases the learners' participation and understanding of complex spatial structures and functions and helps them understand complex abstract topics. By allowing the students to interact with the objects, the participants commented that their learners were more engaged and found the lessons more enjoyable. The participants' comment aligns with Wei et al. (2021), who stated that incorporating AR into education has transformed learning "into a more engaging, interactive, authentic, and joyful environment" (p. 2).

RQ2. *What Barriers, if Any, Have Instructional Designers Experienced in Working With AR?*

Most of the results from this study regarding RQ2 align with those found in the literature review. For example, when the participants discussed the topic of a poorly designed interface, they were referring to the hardware and the software. Some of the hardware issues the participants mentioned concerned hairstyles and goggles. The different hairstyles affected the usability and comfort of the headset, and the goggles were either too heavy or tight. Some students eventually quit wanting to use goggles altogether. Then, the poorly designed software user interfaces were too complicated to use. While focusing on the interface, the students lose sight of what they are supposed to be learning. These software and hardware issues align with Akçayır and Akçayır (2017) and Tzima, Styliaras, and Bassounas (2019), who found that using an AR system is the most reported challenge experienced by students and a poorly designed user interface (UI) affects educational effectiveness.

Another example most participants deemed as a significant contributing barrier to AR acceptance was the lack of an IT infrastructure. The participants in this study mentioned that wi-fi access was a considerable barrier contributor, followed by bandwidth, training, and device tracking and maintenance. They discussed the exorbitant cost of building the AR infrastructure, including the necessary technological equipment. They also mentioned how some students with lower-quality devices could not benefit from AR due to the low bandwidth of their phones or slow processing speeds. The result from this study correlated with a study done by Olivera da Silva et al. (2019) and Alzahrani (2020), where researchers found that a lack of technical infrastructure significantly contributed to the acceptance of AR in the classroom. Perifanou et al. (2023) found that poor infrastructure, such as poor internet connection, lack of devices, and compatibility issues among devices, were the most critical factors hindering teachers from adopting AR.

As another hindrance, three participants discussed the complexity of logistics required to build and implement an AR infrastructure in an educational environment. Their main concern was the logistics of producing quality content, management buy-in, and teacher training. None of the literature review research mentioned the logistics theme, i.e., the logistics of incorporating AR into education or training. Some articles separately and indirectly discussed the logistics of hardware and software requirements (Isa, 2023; Sarigoz, 2019; Uygur et al., 2018), network infrastructure (Jang et al., 2021; Saleem et al., 2020; Sarigoz, 2019), content development (Isa, 2023; Kazanidis, 2021; Tzima, 2019; Zilka, 2021), training and support (Isa, 2023; Perifanou, 2023; Trust et al., 2021), and privacy (Sakr & Abdullah, 2024). Most of the research in the literature review was on the inclusion of AR in logistics and supply chain management (Akbari et al., 2022; Rejeb et al., 2021).

Significant concerns among the study participants were the lack of understanding of AR technology and the cost of training the instructors to design and implement courses using the technology (See Table B1). They believe that the reluctance of instructors to embrace AR technology and the lack of available time for the overworked instructors to learn it contribute to the non-acceptance of AR technology. Alzahrani (2020) and Perifanou, Economides, and Nikou (2023) found that the lack of experience in using the technology, resistance from teachers, the complexity and the high cost of the technology, along with technical issues, such as connectivity problems were challenges to AR acceptance in e-learning.

The barriers discovered in this study align with one or more deficiencies within the TPACK framework. For example, Barroso-Osuna et al. (2019) found that technical difficulties surface when using different devices and operating systems. Zhang et al. (2024) discussed GPS registration problems when working with AR. Derby and Chaparro (2022) and Sinlapanuntakul, Korentsides, and Chaparro (2023) found that low-sensitivity triggers lead to imprecise interactions. With the TPACK framework, these problems would correspond to the TK category. An instructor must have a good grasp of the technology to help the student understand what is happening and how to solve or report the issue.

Table 9 cross-references the themes with previous research in the literature review. The table also cross-references the TPACK categories to which the theme correlates. Since these themes are all barriers to AR acceptance into the classroom, all the TPACK references will be deficiencies. It is essential to know that in its entirety, the TPACK framework provides a solid, successful integration of technology in teaching. The learning efficiency is compromised when one of the framework's components is lacking. Therefore, the cross-referencing to the TPACK framework is included in the table.

Table 8

Cross Reference of Themes with Literature Review Articles and TPACK Framework

Theme	Title	Literature Review Articles	TPACK Categories Affected
2	Ease of use	Akçayır and Akçayır (2017)	TK
2	Equal access	Lin et al. (2023) Zilka (2021)	TCK, TPK
2	Lack of IT structure	Olivera da Silva et al. (2019)	TK, TCK, TPK
2	Not practical	N/A	PK, TPK, PCK
2	Technical difficulties	Barroso-Osuna et al. (2019) Derby and Chaparro (2022) Sinlapanuntakul, Korentsides, and Chaparro (2023) Zhang et al. (2024)	TK
2	Technical skills	Alkhattabi (2017) Ashely-Welbeck & Vlachopoulos, (2020) Njiku (2022)	TK, TPK, TCK
3	Conception	Kale et al. (2020)	TK, TPK, TCK
3	Content	Baran et al. (2020) Pathania et al. (2021)	PCK
3	Curriculum alignment	Njiku (2022)	TPK,TCK
3	Do not understand the technology	Akçayır and Akçayır (2017) Barroso-Osuna et al. (2019) Garzón, Pavón, and Baldiris (2019) Nikimaleki and Rahimi (2022) Trust et al. (2021)	TK, TPK, TCK
3	Faculty resistance	Ashely-Welbeck & Vlachopoulos (2020) Belda-Medina & Calvo-Ferrer (2022) Nikimaleki and Rahimi (2022) Sánchez et al. (2019)	TK

Theme	Title	Literature Review Articles	TPACK Categories Affected
3	Management buy-in	Jang et al. (2021)	TK
4	Logistics	N/A	TK, TPK, TCK
5	Budget	N/A	TK, TPK
5	Building IT structure	Alkhattabi (2017) Barroso-Osuna et al. (2019) Oliveira da Silva et al. (2019)	TK, ICK
5	Cost	Barroso-Osuna et al. (2019) Huang (2021)	TK, TCK
6	Challenge getting people to understand the technology	Akçayır and Akçayır (2017) Barroso-Osuna et al. (2019) Fransson et al. (2020) Garzón, Pavón, and Baldiris (2019)	TK
6	Learning Curve and Professional Development	Lu et al. (2022) Getenet (2020) Huang et al. (2021) Jang et al. (2021) Njiku (2022) Scherer et al. (2020) Sickel (2019) Tusiime et al. (2019)	TK, TPK, TCK
6	Technical skills	Alkhattabi (2017) Ashely-Welbeck & Vlachopoulos (2020) Dirin (2020)	TK, TPK
6	Time	Kuznetsova & Sos (2020) Lichtenstein and Phillips (2021) Phillips (2021) Smith et al. (2020)	TK, TPK, TCK

Note. N/A refers to previous research in the lit review referencing the associated theme.

Summary

. The purpose of this qualitative hermeneutic phenomenological study was to explore instructional designers' perceptions regarding the factors influencing their reluctance to incorporate AR into course designs. The participants for this study were instructional designers with at least three years of experience working as an instructional designer. I conducted a thematic analysis using NVivo 20©, a qualitative data analysis program, to analyze the responses of seven interviewed participants.

I identified two research questions to achieve the purpose of the study. The first research question was an inquiry into the perceptions and experiences of instructional designers in incorporating AR into course designs. The perceptions sought were the instructional designers' feelings regarding using and incorporating AR in an educational environment. The experiences sought were any experiences the instructional designers had in working on real projects using AR. In the interviews, the participants discussed the lack of direct job applications for AR and how AR is useless. Findings demonstrate that participants have tried to incorporate or work with AR. Still, the cost is too steep, especially for something with limited usability.

Participants also discussed AR as an underused tool, people's preference for AR over VR, how any AR barrier can be overcome, the advantages of using AR as a learning tool, management buy-in, and the many ways of using AR. Participants are generally enthusiastic about AR technology but believe AR is underutilized. They believe AR is a good learning tool for education both in and out of the classroom. They also think AR is a more accessible tool than VR and less costly. Participants expressed positive management buy-in with managers who understood the technology.

The second research question was about any barriers instructional designers have experienced in working with AR. The barriers sought were those that were preventing instructional designers from incorporating AR into course designs. Participants' responses were from experience in working either directly or indirectly with AR. I found five themes that addressed the second question. The themes consisted of device usage, lack of understanding or knowledge of the technology, logistics for AR incorporation into the educational environment, money, and concerns regarding the training and time required to implement any AR.

The first theme, device usage, contains six sub-themes – ease of use, equal access, IT structure, not practical, technical difficulties, and required technical skills. The second theme, lack of understanding, contains six sub-themes – conception, content, curriculum alignment, not understanding the technology, faculty resistance, and management buy-in. The third theme, logistics, has no sub-theme. The fourth theme, money, contains three sub-themes – budget, building IT structure, and cost. The fifth theme, training time, contains four themes – the challenge of getting people to understand the technology, the learning curve and professional development, technical skills, and time.

Most themes obtained through the study were referenced in the articles researched in the literature review. However, none of the articles mentioned the theme of Logistics as a barrier. The barriers in this study correlate to one or more deficiencies within the TPACK framework. Since these barrier themes are all barriers to AR acceptance into the classroom, all the TPACK references will have deficiencies.

Chapter 5: Implications, Recommendations, and Conclusions

The problem addressed in this qualitative hermeneutic phenomenological study was the limited understanding of the perceptions of why instructional designers are not using augmented reality (AR) as part of their course development practice. A considerable amount of research has focused on teachers' AR usage in education (Akram et al., 2022; Mundy et al., 2019). However, there was scant literature on the needed requirements and instructional design models to use for designing AR instructional material (Asoodar et al., 2024; Brij & Belhadaoui, 2021; Sarkar & Pillai, 2021) and how there is a need for more studies focusing on instructional design aspects (Xu et al., 2022).

. The purpose of this qualitative hermeneutic phenomenological study was to explore instructional designers' perceptions regarding the factors influencing their reluctance to incorporate AR into course designs. Through this study, I uncovered how instructional designers perceived using AR as a matter of practice. With the results of studies showing the affordances of using AR in the classroom, my study answered why some instructional designers were reluctant to implement AR into course curricula. I developed the following research questions to guide this study:

RQ1. What are the perceptions and experiences of instructional designers in incorporating AR into course designs?

RQ2. What barriers, if any, have instructional designers experienced in working with AR?

Through the first research question, I sought to understand the experiences that instructional designers had in using AR and their perceptions of its use in education. In my study, I sought instructional designers who had at least three years of experience working as instructional designers. Because I was seeking the perceptions of instructional designers, they did not need experience working with AR. In the second research question, I wanted to know what hindrances they felt were preventing them from using AR in their courses.

The theme for the first research question indicated that instructional designers believed there is a future for using AR in the classroom. Instructional designers believed trainers should be encouraged to use AR in schools by first commercially promoting AR. The instructional designers also believed AR would be adopted if the military widely used it. However, its commercial acceptance should not be solely through games because AR would be considered a game tool, not a learning tool. The instructional designers believed AR has a better chance of being accepted commercially than virtual reality (VR) because of the ubiquity of cell phones, lower cost, and interaction with the real world.

The themes for the second research question indicated that instructional designers believed AR's incorporation into education would begin after overcoming numerous challenges. Based on data collection and analysis, I created sub-themes that addressed poorly designed headgear and non-user-friendly software interfaces. The lack of IT infrastructure, equipment, and wi-fi bandwidth discouraged AR implementation. Instructional designers believed that since instructors were unfamiliar with the technology, they lacked the technical skills to develop programs and content and would naturally resist its acceptance. Instructional designers felt that getting people to understand the technology was a challenge. They also felt that getting them to invest the already limited free time the teachers had into personal development and training on AR was yet another challenge.

The limitations associated with my study were small sample size and lack of diversity of participants affecting the generalizability of the findings; participants having preconceived notions about AR, leading to biased responses; variations in participants' familiarity with AR technology influencing their perceptions and responses; differences in access to AR tools and resources impacting the experiences and perceptions of the participants; the limited time the participants had to explore and use AR tools thus affecting the depth of their feedback; low response rates from participants limiting the robustness of the conclusions obtained from the study; and, the fast-paced evolution of AR technology making the findings quickly obsolete.

The organization of this chapter consists of three sections: implications, recommendations, and conclusions. The implications section includes an examination of each research question with my interpretations. I discuss any limitations affecting the interpretation of the results and offer recommendations for practical applications supported by the results. Future research recommendations are outlined in this section as well.

Implications

The preceding chapter focused on the detailed analysis of the two research questions for the primary focus of my study. The qualitative hermeneutic phenomenological study research questions and subsequent research process provided the findings presented in this section. The implications are organized and consistent with the research questions.

Research Question 1

Research question one focused on understanding the experiences that instructional designers had in using AR and their perceptions of the use of AR in education. The primary theme that evolved from the research question related to the usage and applications of AR in education and the job market. The theme includes topics relating to application usage, advantages and preferences, and the challenges perceived with using AR.

For the implications of this research, all seven instructional designers in my study recognized the potential of AR in educational settings, anticipating its future integration into classroom instruction. The optimism shown by the participants in the study was grounded in the belief that the kinesthetic learning approach through the use of AR could significantly enhance students' understanding of complex concepts, a perspective supported by existing literature (Mystakidis et al., 2021). The literature highlights the role AR has in improving conceptual comprehension and skill acquisition. The participants recognized the capacity of AR to create immersive and engaging learning experiences, aligning with research highlighting the positive impact AR can have on learner motivation, student engagement, conceptual understanding, and knowledge retention (Hidayat & Wardat, 2024; Koumpouros, 2024). The preference for AR over VR and mixed reality (MR), attributed to accessibility and grounded nature, suggested a greater comfort level with the ability to enhance, rather than replace, real-world experiences and from its perceived accessibility, affordability, and alignment with kinesthetic learning principles. The preference for AR over VR and MR resonated with studies emphasizing the importance of contextual relevance and user-friendliness for successful technology integration in education (Isa, 2023; Scherer et al., 2020). Specifically, the ability to interact with virtual objects overlaid in the real world resonates with constructivist learning theories, which emphasize the importance of active learning and experiential knowledge construction (Sarigoz, 2019; Scavarelli et al., 2021).

Despite acknowledging AR usage's potential, participants expressed reservations regarding its practical application. The limited availability of pedagogically sound AR content and the lack of established AR integration models within existing curricula emerged as significant barriers. The findings underscored the need for collaborative efforts between educators, instructional designers, and AR developers to create and disseminate high-quality AR resources that aligned with specific learning objectives and curricular needs (Bacca et al., 2014; Fearn & Hook, 2023; Isa, 2023; Kazanidis et al., 2021.; Tzima et al., 2019).

Participants also expressed concerns about the technological and financial challenges of implementing AR. The perceived high entry cost presented a significant financial barrier, particularly for resource-constrained educational institutions. The finding on financial challenges aligned with existing literature emphasizing the need for cost-effective AR solutions and sustainable funding models to support broader adoption in education (Fearn & Hook, 2023). Additionally, the perceived underdevelopment of AR technology and the limited availability of job opportunities directly related to AR expertise may create uncertainty and hesitation among instructional designers regarding its long-term viability and their investment in professional development and advocacy for AR integration. The participants' view on the limited usability of AR in the job market partially aligned with a literature review that states that the primary use of AR is in engineering, health and medicine, and pedagogy. The same literature review showed an upward trend in professional development within the past two decades (Han et al., 2022).

Research Question 2

Research question two aimed to explore the potential reluctance instructional designers had in implementing AR as a matter of practice. Five primary themes evolved from the research question about barriers to AR acceptance. The themes derived are device usage, lack of understanding, logistics, money, and training time. The five themes derived from my study and listed below shed light on instructional designers' challenges, thus contributing to a better understanding of AR integration in educational settings:

- Device usage: deals with any aspect of using the tool, such as ease of use, practicality, technical difficulties, skills required, and IT issues.
- Lack of understanding: encompasses the issues where the instructional designer, instructor, or student lacks the conceptual or practical knowledge to apply or adopt the tool.
- Logistics: covers all logistics needed to integrate AR into the educational environment.
- Money: covers budgets and costs of building an IT structure.
- Training time: deals with the time required to educate and train people on understanding the technology and developing the required technical skills.

Consistent with recent studies, the findings underscored the importance of technological readiness and institutional support for successful AR adoption (e.g., Dogan et al., 2020; Shihab et al., 2023; Smith et al., 2020). The device usage and logistics barriers aligned with prior research emphasizing infrastructure and accessibility challenges (Smith et al., 2020). The issues related to device usage and logistics, such as inadequate internet bandwidth and lack of IT structures, resonated with prior research emphasizing the necessity of robust technological frameworks in educational institutions (Shihab et al., 2023).

Previous research, such as Isa (2023), has highlighted the pronounced reluctance among veteran educators to embrace AR, driven by fears of obsolescence and the steep learning curve. Findings by Bowman et al. (2022) and Akram et al. (2022) indicate that professional development programs can help older teachers overcome their fears of using new technological tools. The findings by Bowman et al. and Akram et al. align with the findings of my study, which also suggests that such programs can benefit older teachers who lack the necessary training and support.

The significant financial constraints identified by participants also highlighted the need for strategic investments and cost-effective solutions for AR integration. Moreover, the high cost associated with AR implementation suggests the necessity for comprehensive budgeting and resource allocation strategies to facilitate adoption. The cost and financial implications, such as initial investment, content development, maintenance, training, and technical support, aligned with the findings of Isa (2023).

The three conceptual frameworks that supported my study and were applicable for instructional designers to use in their AR coursework were the ASSURE model (Heinich, Molenda & Russell, 1982), the TPACK framework (Mishra & Koehler, 2006), and the Kirkpatrick model (Kirkpatrick, 1994). These models are used in instructional design to guide the development and evaluation of learning experiences (Alsalamah & Callinan, 2021; Kholid et al., 2023; Stefaniak & Xu, 2020). By understanding and applying these models, designers could ensure that AR is effectively integrated into learning experiences, aligned with learner needs and objectives, and evaluated for effectiveness. Below is a synopsis of the ASSURE, TPACK, and Kirkpatrick models and their relevance to the study.

The ASSURE model, grounded in constructivist learning theory (Heinich, Molenda & Russell, 1982), provides a systematic approach to instructional design that is particularly well-suited for integrating AR into learning experiences. By focusing on the learner’s needs and actively involving them in the learning process, the ASSURE model ensures that educators use AR effectively to enhance understanding and skill development. The ASSURE model outlines six key steps:

1. Analyze the learner's needs and characteristics, considering their prior knowledge, technical skills, and learning styles.
2. State clear and measurable learning objectives that align with the desired outcomes of the AR experience.
3. Select appropriate AR tools, media, and content that are relevant, engaging, and accessible to the learners.
4. Utilize the selected media effectively by designing interactive and immersive AR experiences that stimulate learner curiosity and critical thinking.
5. Require active learner participation through tasks and activities that promote exploration, problem-solving, and knowledge construction.
6. Evaluate the effectiveness of the AR-integrated learning experience by assessing learner achievement, engagement, and satisfaction.

In the study, I found that while a limited number of participants experimented with AR content creation, they did not follow the ASSURE model for instructional design. Despite lacking formal training in integrating AR into teaching materials, they were able to develop AR content. However, they did not consider applying the ASSURE model to structure and guide their instructional design process effectively.

The TPACK model, a framework that integrates technology into teaching by balancing content, pedagogical, and technological knowledge (Mishra & Koehler, 2006), is a powerful tool for instructional designers working with AR. The TPACK model, aligned with experiential learning theory, emphasizes learning through experience and reflection. By considering the intersection of the following three key knowledge domains, instructional designers can create effective and engaging AR-based learning experiences:

1. Technological knowledge: A deep understanding of AR technologies, their limitations, and their potential applications in education is crucial.
2. Pedagogical knowledge: Designing AR-based learning experiences that align with effective teaching and learning principles, such as active learning and learner-centered approaches, is essential.
3. Content knowledge: Integrating AR into content areas in a meaningful and relevant way, ensuring the technology enhances rather than distracts from learning, is a core component of the TPACK model.

My study revealed that participants overlooked the TPACK model when developing AR content, similar to the ASSURE model previously discussed. While some participants demonstrated partial technological knowledge of AR technologies, they lacked formal training in AR content creation and instructional integration. The absence of training prevented them from utilizing the TPACK model to guide their instructional design process.

The Kirkpatrick model, a widely recognized framework for evaluating training programs (Kirkpatrick, 1994), offers a robust approach to assessing the effectiveness of AR-based instruction. This model aligns well with situated learning theory, emphasizing learning within authentic contexts and through social interactions. By focusing on four levels of evaluation—reaction, learning, behavior, and results—the Kirkpatrick model provides a comprehensive approach to measuring the impact of AR-based instruction on learner outcomes. Here is how each level of the Kirkpatrick model could align with AR integration:

1. Reaction**:** This level assesses learners' initial perceptions and reactions to AR-based instruction. In the context of AR, this involves evaluating learners' satisfaction with the

AR experience, their engagement with the technology, and their overall perception of the AR's usefulness.

2. Learning**:** This level measures whether learners have acquired new knowledge, skills, and attitudes due to AR-based instruction. For AR, this involves assessing learners' ability to use AR tools effectively, their understanding of AR concepts, and their ability to apply AR to problem-solving.
3. Behavior**:** This level evaluates whether learners apply the knowledge and skills gained from the AR-based instruction to their work or other relevant contexts. In the case of AR, this involves assessing learners' ability to create their own AR experiences, use AR in collaborative projects, or integrate AR into their everyday learning practices.
4. Results**:** This level assesses the overall impact of AR-based instruction on organizational or individual performance. For AR, this involves measuring improvements in learner achievement, increased motivation, enhanced problem-solving skills, or increased creativity due to using AR.

By systematically evaluating each level of the Kirkpatrick model, instructional designers can gain valuable insights into the effectiveness of AR-based learning experiences and make data-driven decisions to optimize future implementations. However, my study did not include mentions from the limited participants of evaluations at any level of the Kirkpatrick model. The oversight can likely be attributed to a lack of training in integrating AR with the Kirkpatrick model, highlighting the importance of such training for comprehensive learning evaluations.

Recommendations for Practice

The purpose of this qualitative hermeneutic phenomenological study was to explore instructional designers' perceptions regarding the factors influencing their reluctance to incorporate AR into course designs. Through in-depth interviews with seven experienced instructional designers, I sought to understand their perceptions of acceptance, experience, willingness, and unwillingness to adopt AR in their practice. A key finding revealed that while instructional designers recognized the immersive and engaging nature of AR, several barriers hindered its widespread adoption, aligning with those listed in Alzahrani (2020).

Technological challenges frequently cited by the participants were hardware limitations, device compatibility, and internet connectivity (Shihab et al., 2023). Financial constraints related to the cost of AR equipment, infrastructure, and content development were also significant barriers (Belda-Medina & Calvo-Ferrer, 2022; Fearn & Hook, 2023; Isa, 2023). Lack of understanding of AR's capabilities, its integration with curricula, and its distinction from other technologies like virtual reality and mixed reality contributed to resistance among educators (Trust et al., 2021). Additional concerns were logistical issues related to server infrastructure, security, and maintenance (Alzahrani & Alfouzan, 2022; Smith et al., 2020). Finally, the training time required to learn and implement AR was perceived as a barrier, particularly for educators already burdened with multiple responsibilities (Akram et al., 2022; Sims et al., 2021). These findings underscored the need for targeted strategies to address these challenges and facilitate the broader integration of AR into educational practices (Isa, 2023). Despite these challenges, participants expressed optimism about AR's future in education, highlighting its potential to revolutionize teaching (Ghanbaripour et al., 2024) and learning (Bui & Nguyen, 2023). Based on the findings of my study, this section outlines several recommendations for practice to promote the integration of AR into educational institutions.

To overcome the barriers associated with the steep learning curve and technical complexity associated with AR, institutions should prioritize professional development programs focused on AR to address the lack of understanding and technical skills among faculty (Chih et al., 2024; Isa, 2023; Kazanidis et al., 2021). These programs should cover the basics of AR technology (Fearn & Hook, 2023; Perifanou et al., 2023), its pedagogical applications and benefits, best practices for integrating AR into curricula, and its limitations (Barroso-Osuna et al., 2019; Belda-Medina & Calvo-Ferrer, 2022). Furthermore, training programs should include hands-on experiences (Jesionkowska et al., 2020) that allow instructional designers to experiment with various AR tools and applications. These training programs will help them familiarize themselves with the technology and develop confidence (Fearn & Hook, 2023; Yaw, 2024).

The availability of high-quality AR educational content is crucial for its effective integration into curricula (Shihab et al., 2023). The scarcity of high-quality AR content was recognized as a significant barrier to adoption (Isa, 2023; Perifanou et al., 2023). Educational institutions should collaborate with content creators, instructional designers, subject matter experts, and policymakers to develop high-quality AR content that aligns with existing curricula and learning objectives (Kazanidis et al., 2021; Perifanou et al., 2023; Shihab et al., 2023). When designing AR content, designers should consider that all students should be able to access AR content regardless of their technical skills, disabilities (Hersh & Mouroutsou, 2019; Quintero et al., 2019; Shihab et al., 2023), or background (Isa, 2023). Considering the design of AR content for all students may involve guiding the use of AR devices and creating inclusive and culturally relevant content (Isa, 2023). It may also require incorporating features such as closed captioning, alternative input methods, and visual accommodations (not explicitly mentioned in the findings but a relevant consideration).

Sharing high-quality content through open-access platforms can facilitate broader adoption and experimentation, thus encouraging instructional designers to explore innovative ways to incorporate AR into their teaching practices (Perifanou et al., 2023). Creating online and offline communities can further help to share best practices, resources, and experiences related to AR (Akman et al., 2019; Lee et al., 2023). These communities will foster collaboration, support, and professional development (not explicitly mentioned in the findings but a relevant recommendation) (Calderón & Tannehill, 2021).

To help encourage innovation among instructional designers, institutions should invest in curriculum development and alignment programs to ensure innovation and the effective integration of AR into educational practices (Rahmawati et al., 2020). Encouraging a culture of innovation and experimentation is the key to overcoming resistance to new technologies (Perifanou et al., 2023). Hackathons, design challenges, and funding opportunities for instructional designers to explore AR projects are ways an institution can achieve a culture of innovation and experimentation (Flus & Hurst, 2021; Perifanou et al., 2023; Wei et al., 2021). Institutions can foster a more positive attitude towards AR and its potential benefits by creating a supportive environment and allowing instructional designers to take risks and try new approaches to teaching and learning with AR (Jang et al., 2021). When educators can explore AR applications, collaborate with their peers, and share their experiences, they can significantly enhance their comfort and enthusiasm for integrating AR into their teaching practices (Romano et al., 2023; Wei et al., 2021).

The study highlighted several technological barriers, such as limited internet access and insufficient IT infrastructure. To overcome these challenges, institutions should invest in the infrastructure required to support the use of AR, including high-speed internet, compatible devices, adequate technical support, and ongoing maintenance (Isa, 2023). Regular maintenance and updates of AR devices and software are essential to minimize technical difficulties and ensure optimal performance (Shyr et al., 2021).

The institutions should prioritize allocating adequate funds for procuring necessary hardware, software, and content development (Perifanou et al., 2023). Technology investment ensures a seamless AR experience for students and faculty. However, the high cost of AR technology can be a barrier for many institutions (Isa, 2023; Perifanou et al., 2023). Institutions should explore cost-effective solutions to mitigate this, such as leveraging existing devices or partnering with technology providers to negotiate favorable terms. Additionally, advocating for increased funding for educational technology or exploring other funding sources, such as grants, partnerships, and donations, can help address financial constraints (Isa, 2023; Rogers et al., 2024).

Collaborating with industry partners can provide valuable insights, resources, and expertise in AR development and implementation in educational settings (Isa, 2023). Collaborating with companies can help obtain access to cutting-edge technology and develop industry-relevant AR applications (Isa, 2023). Collaborations can also include training and professional development opportunities for the instructional designers, ensuring they are well-equipped to integrate AR into their teaching (Isa, 2023). Lastly, instructional designers can build a network of professionals and experts through these partnerships to provide valuable connections and potential future collaborations (About iLRN 2021).

Recommendations for Future Research

It became clear from the literature review and the findings of my study that more research is necessary to address the issue of instructional designers' hindrance in integrating AR into course curricula. The findings do highlight a general optimism among instructional designers like those found by Garzón (2021) about the potential of AR to revolutionize learning experiences. The instructional designers envision AR as a tool to enhance student engagement, comprehension, and motivation. The instructional designers believe that the ability of AR to create immersive and interactive learning environments aligns with contemporary pedagogical approaches that prioritize active learning and experiential knowledge construction (Cai et al., 2022; Videnovik et al., 2020).

The findings of my study attributed the barriers to the widespread adoption of AR to various significant challenges. Some of the challenges aligning with Isa (2023) are the high cost of AR technologies (i.e., the initial investment in hardware, software, and content creation) and the steep learning curve associated with their use. These challenges posed significant financial and technical barriers, particularly for resource-constrained institutions, emphasizing the need for cost-effective AR solutions and sustainable funding models to support broader adoption. Another challenge was the lack of high-quality, pedagogically sound AR content, which aligns with the lack of AR content barrier in a study by Perifanou et al. (2023).

Another barrier hindering implementation is the absence of established AR integration models within curricula. Akram et al. (2022) specified that the lack of appropriate pedagogical models hinders effective technology integration. Another critical challenge is the resistance of some instructors to embrace new technologies. The instructors' resistance stems from a variety of factors, including a lack of technological literacy, lack of adequate training and support, concerns about the effectiveness of AR, and fear of the unknown, which are in line with previous research (Barroso-Osuna et al., 2019; Perifanou et al., 2023) indicating that there are a lack technical skills, training and support, doubts about the effectiveness of AR in the classroom, and fear of the unknown, especially among the older educators. My findings, which align with Isa's (2023) and Perifanou et al. (2023), suggest that overcoming instructor resistance to AR requires targeted professional development to equip educators with the necessary skills and knowledge to use AR effectively.

The findings of my study provided valuable insights into the perceptions and experiences of instructional designers incorporating AR into course designs. Several areas remain ripe for further exploration. For example, by building upon the findings from the study, we can deepen our understanding of AR's implementation barriers. While the findings of my study identified several barriers like those in Upadhyay et al. (2024), future research could delve deeper into specific challenges, such as the technical complexities, cost implications, and pedagogical considerations associated with AR implementation.

We could also explore the role of professional development. Like Mercaer and Gairín (2020) and Chih-Wei et al. (2024), my research underscores the importance of training and professional development for educators to integrate AR effectively into their teaching practices. Future research should investigate the effectiveness of various training models to equip educators with the necessary skills and knowledge to leverage AR in the classroom.

Another area for investigation would be the impact of AR on student learning outcomes. While my study focused on instructional designers' perspectives, future research could examine the direct impact of AR on student engagement, motivation, and achievement. Such a study would add to the existing body of knowledge base and align with the findings of Maas and Hughes (2020).

We could further research the ethical implications of AR in education. As AR technology advances, it is crucial to consider the ethical implications, including privacy, accessibility, and digital equity. Privacy concerns arise when AR applications collect personal data or put users at risk (Isa, 2023). Accessibility is crucial to ensure that diverse users, including people with disabilities, can use AR content (AlGerafi et al., 2023; Isa, 2023). Digital equity disparities, such as those caused by socioeconomic status, geography, and education, can widen the digital divide (AlGerafi et al., 2023; Isa, 2023; Yaw, 2024).

In addressing the limitations of the study, we could expand the sample size and combine qualitative and qualitative methods for future research. A more extensive and diverse sample of instructional designers could provide a more comprehensive understanding of their perceptions and experiences. By combining qualitative and quantitative methods, we can obtain a more robust and nuanced analysis of the research questions. For example, using surveys, we can gather data on a larger scale, while interviews could provide in-depth insights.

Another future research could be through the use of longitudinal studies. We could use longitudinal studies to understand the long-term impact of AR on instructional design practices or track changes in perceptions, attitudes, and behaviors over time. A final idea addressing the limitations of the study could be in-depth case studies of successful AR implementations that could provide valuable insights into the factors contributing to successful integration.

The findings of my study have significant implications for future research in the field of AR in education. For example, one key area would be developing effective AR instructional design frameworks and models. Future research could focus on developing comprehensive frameworks that guide AR-based learning experiences, design, and implementation, as Kazanidis et al. (2021) exemplified. These frameworks should consider learning objectives, learner characteristics, technological constraints, and assessment strategies, which aligns with Czok et al. (2023).

The exploration of the impact of AR on different learning styles and modalities could be another research area. Chandrasekera and Yoon's (2018) findings support this recommendation that AR can cater to diverse learners, including visual, auditory, and kinesthetic learners. In addition, the study could also explore the effectiveness of AR in promoting active learning, problem-solving, and critical-thinking skills, as suggested by Liu et al. (2023) and studied by Amores-Valencia et al. (2023) on the performance of High School students using AR.

Another area for future research is the role of AR in fostering collaboration and social interaction among students. Building on the findings of Savela et al. (2020) and Jifan et al. (2024), which demonstrated high levels of collaboration and social interaction in AR environments, future research could explore specific applications such as group projects (Swati et al., 2024), virtual field trips (Pathania et al., 2023), and simulations (Kaminska et al., 2023; Pathania et al., 2023; Ruiz-Ortega et al., 2024). Researchers can better understand how AR can enhance collaborative learning and social experiences by investigating these areas.

Conclusions

My study explored instructional designers' perceptions and experience of using AR in course design, a largely uncharted territory in educational research. Several articles about AR use in various education levels were analyzed (Czerkawski & Berti, 2021; Fearn & Hook, 2023; Han et al., 2022; Marrahí-Gómez & Belda-Medina, 2022; Perifanou et al., 2023). Participants in the study agreed that the potential of AR to transform learning experiences through interactive and immersive content was well-established. While there is growing interest in the promise of AR to enhance learning, the findings from my study showed that instructional designers are enthusiastic about the potentiality of AR to enhance the learning experience, but several barriers hinder its widespread adoption. The barriers discovered through my study include:

- Device usage: Concerns related to device compatibility, ease of use, and technical difficulties.
- Lack of understanding: Limited knowledge and understanding of AR technology, its pedagogical applications, and its integration into existing curricula.
- Logistics: Challenges associated with implementing AR in educational settings, including infrastructure requirements, content development, and technical support.
- Money: Financial constraints for acquiring AR devices, software, and ongoing maintenance.
- Training time: Professional development to equip instructional designers with the necessary skills and knowledge to utilize AR effectively.
- Support among educators: Collaboration between instructional designers, educators, and technology experts to develop high-quality AR content and effective integration strategies.

These findings underscored the need for comprehensive support, training, and resources to facilitate the adoption of AR in education. Institutions should invest in professional development programs that effectively equip instructional designers with the technical skills and pedagogical knowledge to integrate AR into their courses, providing them with hands-on experience and guidance on AR implementation. Furthermore, institutions should invest in robust technological infrastructure and allocate sufficient resources to support AR implementation.

Instructional designers and institutions can take steps to overcome the barriers discovered in my study and effectively align AR into their curricula with sound instructional design principles, such as those embodied in the ASSURE, TPACK, and Kirkpatrick models. In addressing these challenges, instructional designers will cater to the needs of the digital generation and unlock the potential of AR to revolutionize education and create engaging, immersive learning experiences. Only by understanding the instructional designers' perspectives and experiences can this research contribute to a more informed and effective implementation of AR in educational settings.

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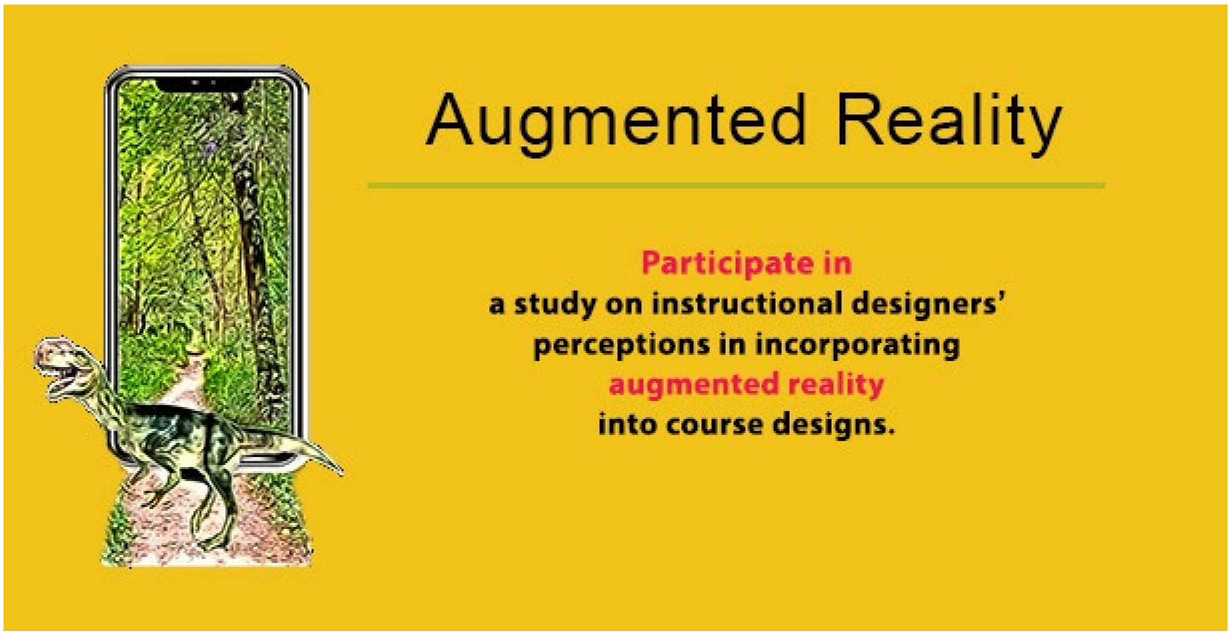
Appendix A

Image and Text for Social Media Posts



Do you have at least three years of instructional design experience?

If so, consider participating in a research study on instructional designers' perceptions in incorporating augmented reality into course designs. Participants in this study will:

1. Participate in an online interview via Zoom for not more than 40 minutes.
2. Review the one-on-one interview transcript via email for 10-15 minutes.
3. The first five participants can also participate in a focus group that will not exceed 40 minutes.

If you participate, you will be asked questions about the following:

- Any experience you may have in working with augmented reality.
- Your perception of incorporating augmented reality into learning materials.
- Any barriers you have encountered in working with augmented reality.
- Brief profile information on your specialty, additional studies, and years as an instructional designer.

To participate, scan the QR code:

Email g.briceno5136@o365.ncu.edu with questions. Thank you!

George Briceno
Doctoral Candidate at Northcentral University

Appendix B

Interview and Focus Group Questions

Questions for the one-on-one interviews and the focus group:

1. What experience do you have in working with augmented reality?
2. What is your perception of incorporating augmented reality into learning materials?
3. What barriers, if any, have you encountered in working with augmented reality?

Appendix C

Focus Group Meeting Agenda

I will afford the participants in the research autonomy and respect, and the participants' consent will be informed and voluntary.

In general, the focus group meeting outline is as follows:

1. Salutations and an explanation of the project.
2. Set the ground rules.
    a. Discussions within the group are confidential.
    b. Only one person talks at a time.
    c. No unnecessary interruptions will be allowed.
    d. All views and comments will be respected.
    e. Inform participants of the making of a video recording of the session.
3. Ask open-ended questions about the research (see Appendix B).
4. Repeat, restate, and incorporate the participants' words when asking questions.
5. Perhaps create hypothetical situations when asking questions.
6. Finish the meeting by thanking each participant.

We will inform the participants that the meeting will last about 40 minutes, but we will try to finish the meeting sooner to prevent the quality degradation of the feedback.

Appendix D

Consent Letter

Introduction

My name is George Briceno, and I am a doctoral student at National University (NU).

I am conducting research on instructional designers' perceptions and experiences in incorporating augmented reality into course designs. The name of this research is "Exploring Instructional Designers' Perceptions and Experiences of Why They Are Not Using Augmented Reality as Part of Their Course Development Practice." I am seeking your consent to participate in this research.

Please read this document to learn more about this research and determine if you would like to participate. Your participation is completely voluntary, and I will address your questions or concerns at any point before or during the research.

Eligibility

You may participate in this research if you meet all of the following criteria:

1. You have at least three years of instructional design experience

I hope to include 8 to 10 people in this research.

Activities

If you decide to participate in this research, you will be asked to do the following activities:

1. Participate in an online interview via Zoom for not more than 40 minutes.
2. Review the one-on-one interview transcript via email for 10-15 minutes.
3. The first five participants can also participate in a focus group that will not exceed 40 minutes.

During these activities, you will be asked questions about:

- Any experience you may have in working with augmented reality.
- Your perception of incorporating augmented reality into learning materials.
- Any barriers you have encountered in working with augmented reality.
- Brief profile information on your specialty, additional studies, and years as an instructional designer.

All activities and questions are optional: you may skip any part of this research that you do not wish to complete and may stop at any time.

If you need to complete the activities above in a different way than I have described, please let me know, and I will attempt to make other arrangements.

Risks

There are no foreseeable risks or discomforts associated with this research. You can still skip any question you do not wish to answer, skip any activity, or stop participation at any time.

Benefits

If you participate, there are no direct benefits to you. This research may increase the body of knowledge in the subject area of this research.

Privacy and Data Protection

I will take reasonable measures to protect the security of all your personal information, but I cannot guarantee the confidentiality of your research data. In addition to me, the following people and offices will have access to your data:

- My NU dissertation committee and any appropriate NU support or leadership staff
- The NU Institutional Review Board

This data could be used for future research studies or distributed to other investigators for future research studies without additional informed consent from you or your legally authorized representative.

I will securely store your data for 3 years. Then, I will delete electronic data and destroy paper data.

How the Results Will Be Used

I will publish the results in my dissertation. I may also share the results in a presentation or publication. Participants will not be identified in the results.

Recording

I would like to audio/video record your responses with Zoom during the interview. You can disable the video function of the online meeting platform at any time.

Contact Information

If you have questions, you can contact me at: g.briceno5136@o365.ncu.edu.

My dissertation chair's name is Dr. J. Summerville. She works at National University and is supervising me on the research. You can contact her at: jsummerville@ncu.edu.

If you have questions about your rights in the research or if a problem or injury has occurred during your participation, please contact the NU Institutional Review Board at irb@nu.edu.

Voluntary Participation

If you decide not to participate or stop participation after you start, there will be no penalty to you: you will not lose any benefit to which you are otherwise entitled.

Appendix E

Recruitment Email

My name is George Briceno, and I am a doctoral student at National University. I am conducting a research study on why many instructional designers are not using augmented reality as a matter of practice.

I am recruiting individuals who meet all of these criteria:

1. You have at least three years of instructional design experience.

If you decide to participate in this study, you will be asked to do the following activities:

1. Participate in an online interview via Zoom for not more than 40 minutes.
2. Review the one-on-one interview transcript via email for 10-15 minutes.
3. The first five participants can also participate in a focus group that will not exceed 40 minutes.

During these activities, you will be asked questions about:

- Any experience you may have in working with augmented reality.
- Your perception of incorporating augmented reality into learning materials.
- Any barriers you have encountered in working with augmented reality.
- Brief profile information on your specialty, additional studies, and years as an instructional designer.

If you have questions or are interested in participating in this study, please contact me at g.briceno5136@o365.ncu.edu or scan the QR code to reply with a pre-filled-out email form:

Thank you!

George Briceno

Appendix F

RQ1 Synopsis

Regarding the research question, “What are the perceptions and experiences of instructional designers in incorporating AR into course designs?” a single theme emerged. The theme is: Usage and Applications - Advantages, preferences, and challenges of using AR. The theme has three sub-themes, which are (1) Advantages and preferences, (2) Application and usages in education and the job market, and (3) Challenges. Most discussions centered around the sub-theme “Application and usages in education and the job market,” closely followed by “Advantages and preferences.” The order of mentions in the research for each sub-theme in ascending order is shown in Table F1. Following Table F1 are the findings for each sub-theme. Figure F1 shows the data breakdown of the theme and sub-themes.

Table F1

Ascending Order of RQ1 Sub-Theme Mentions

Sub-Theme	Number of mentions
Challenges	6
Advantages and preferences	23
Application and usages in education and the job market	26

Figure F1

Research Question 1: Usage and Applications - Advantages, Preferences, and Challenges of using AR

Name	Files	References
Usage and Applications - Advantages, preferences, and challenges of using AR	8	55
Advantages and Preferences	7	23
Application and Usages in education and the job market	8	26
Challenges	5	6

Note. Screenshot of the Perceptions - Usage and Applications results from NVivo 20©.

Advantages and Preferences.

Four participants placed AR as a "cool," "fun," "enjoyable," or "incredible" tool. P3 simply said, "I think it's an incredible tool," whereas P7 expounded a little more, "There's just this huge collaborative piece that's such a cool opportunity for learning." One participant believes that "it's where the future is going." Three participants mentioned that they prefer AR over either VR or MR. Three other participants made reference to the use of AR in various situations. P1 said, "I find it hard-pressed to find a project that couldn't use it in some way." P2 added, "I think, in catering to education, not just K-12, but think about post-secondary and nursing training and things like that." P3 contributed, "I think augmented reality is a great tool for my high school. I think that there and I, I pick high school. I think middle school probably would be okay, too." Four participants commented on the value that AR brings to education.

Application and Usages in Education and the Job Market.

Three participants used AR in education and stated that their experience was enjoyable or that they were impressed. P2 said, "As a teaching tool, as a learning tool, as a creativity tool, it's an amazing resource." Seven participants provided ideas for AR's use. P2 shared the following, "the ability to do simulations with AR and to pull up things like the human body or the interior workings of an engine so you can take it apart piece by piece without actually messing up a real engine. That kind of thing has value." P5 provided another example, "I think augmented reality would be phenomenal for your classes, for like scavenger hunts or for things like, um, safety, um, safety classes where they're having to find where all the issues are."

Two participants stated that AR is a technology that is underused or unknown. Seven participants commented on the use of AR in education. One participant talked about the use of AR in entertainment. P7 commented on the use of AR in the job market: "I think the easiest use for it would be like industrial training space… I think especially in jobs that you are that require people to, you know, more blue-collar jobs where you're actually handling real space, real-time and space for training materials in real life."

Challenges.

The participants mentioned four challenges. Four participants discussed funding or cost as a challenge. P7 stated, "There's even a cost, a pretty, pretty steep cost for that." One participant commented on how they were collecting funds, "doing group funding between organizations is what we're looking at like if everyone pitches in, could we get this product collectively?" A second challenge is that AR is not a proven technology for learning. P2, the only participant to mention this challenge, said, "If we don't do a tie into the end result if it doesn't improve test scores, unfortunately in K-12 or increase completions of programs and hiring of jobs, it's not going to be a money investment for anybody." One participant discussed a personal challenge experienced when using the device. The participant, P3, said, "I was very nauseous when I first put it on and over and over again." The final comment on challenges by P2 was, "There are a lot of barriers out there, but I don't think that any of them are insurmountable."

Appendix G

RQ2 Synopsis

Regarding the research question, “What barriers, if any, have instructional designers experienced in working with AR?” five themes emerged. The themes are device usage, lack of understanding, logistics, money, and training time. Most participants expressed concerns about a lack of understanding or knowledge of AR, usage of the device, and the technical skills and training needed before AR can advance into the classrooms. The order of mentions in the research for each theme in ascending order is shown in Table G1. Following Table G1 are the findings for each theme.

Table G1

Ascending Order of RQ2 Theme Mentions

Theme	Number of mentions
Logistics	3
Money	10
Training time	16
Device usage	18
Lack of understanding	24

Device Usage.

Two participants cited ease of use as being a barrier. One participant mentioned the barrier of using the headgear and skin tone, and the other commented, "You have to be careful with how you use it." Three participants mentioned equal access, and three mentioned many problems with the IT Structure. One participant viewed AR as a non-practical tool. Four participants listed various technical difficulties, and five discussed barriers dealing with technical skills. See Figure G1.

Figure G1

Research Question 2: Device Usage Sub-Themes

Name	Files	References
Device usage	7	41
Ease of use	2	6
Equal access	3	3
Lack of IT Structure	3	10
Not practical	1	4
Technical difficulties	4	10
Technical skills	5	8

Note. Screenshot of the Device Usage Barriers results from NVivo 20©.

Lack of Understanding.

Four participants contributed conception barriers to not understanding how AR can be used in education. Four participants listed poor quality or not enough content available. Three participants listed barriers to incorporating AR into the curriculum. Three participants contributed to faculty resistance from not wanting to take on another tool to learn to fear of being replaced by the tool. Five participants contributed numerous barriers to the theme of lack of understanding or knowledge. Five participants shared their thoughts on barriers to management buy-in. See Figure G2.

Figure G2

Research Question 2: Lack of Understanding Sub-Themes

Name	Files	References
Device usage	7	41
Lack of understanding	8	42
Conception	4	6
Content	4	6
Curriculum alignment	3	5
Do not understand the technolo	5	14
Faculty resistance	3	6
Management Buy-in	5	5

Note. Screenshot of the Lack of Understanding Barriers results from NVivo 20©.

Logistics.

Three participants discussed some of the logistics necessary to implement AR. The logistics entailed training, device maintenance, security, and others. P7 stated, “There’s logistical issues, and it does take time.”

Money.

The barriers for the money theme consist of three types: budget, cost, and IT structure. Two participants discussed budget issues. Five participants talked about the cost of AR, and three about the cost associated with setting up the IT infrastructure. Most were concerned with the cost of AR, followed by the cost of the IT infrastructure. See Figure G3.

Figure G3

Research Question 2: Money Sub-Themes

Name	Files	References
Device usage	7	41
Lack of understanding	8	42
Logistics	2	3
Money	7	20
Budget	2	2
Building IT Structure	3	8
Cost	5	10

Note. Screenshot of the Money Barriers results from NVivo 20©.

Training Time.

Five participants cited the lack of understanding or knowledge as being a barrier. Four mentioned technical skills, and three mentioned time as barriers to AR acceptance. Four participants discussed training as being an obstacle. The barriers most mentioned in the interviews were lack of understanding or knowledge, and training. See Figure G4.

Figure G4

Research Question 2: Training Time Sub-Themes

Name	Files	References
Device usage	7	41
Lack of understanding	8	42
Logistics	2	3
Money	7	20
Training time	6	29
Challenge getting people to und	5	9
Learning Curve and Professional	4	8
Technical skills	4	6
Time	3	6

Note. Screenshot of the Training Time Barriers results from NVivo 20©.