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Augmented and virtual reality in education: A comparative study of teacher perceptions in Saudi Arabia and Jordan

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Abstract

This study explores teachers' perceptions of augmented reality and virtual reality as emerging instructional tools in public schools. It addresses a research gap concerning educators' readiness and attitudes toward integrating immersive technologies into classroom practice. The objective was to understand how teachers perceive the educational value of these technologies and whether their perspectives vary according to professional experience and academic qualification. Adopting a descriptive survey design, data was collected from 199 teachers using a validated instrument. The analysis indicated a moderate level of familiarity and application of augmented and virtual reality in teaching practices. Differences in perception were observed across experience levels and educational backgrounds. The findings suggest that despite growing awareness, the pedagogical integration of these technologies remains limited by insufficient training and institutional support. The study underscores the importance of professional development programs and policy initiatives to enhance teachers' competence and confidence in utilizing immersive tools for innovative learning.

***Keywords*:** Augmented reality; education; teachers; technology integration; virtual reality.

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1. INTRODUCTION

In the contemporary world, societies are undergoing a remarkable transformation characterized by an exponential increase in knowledge and technological advancements, a phenomenon often termed the "knowledge explosion." This rapid proliferation of information and technology is not merely a backdrop but serves as a defining feature of modern existence, posing significant challenges to educational systems globally. As educational institutions endeavor to navigate the intricate dynamics of this evolving landscape, they face the dual task of harnessing the benefits of technological innovations while also actively shaping their integration into educational practices. The urgency for educational institutions to adapt to the demands of a digital generation, alongside the pressures of globalization and competitive educational and economic environments, has never been more pronounced. This urgency has catalyzed a significant evolution in e-learning systems, which have progressed from traditional Computer-Based Instruction (CBI) and Computer-Managed Instruction (CMI) to more sophisticated frameworks that leverage advancements in Information and Communication Technology (ICT).

The acceleration of technological progress permeates every aspect of daily life, fundamentally reshaping how individuals access and engage with information. As Al-Hajili (2020) aptly states, "technology is the future, and the future is technology," highlighting the critical role that technological innovations play in shaping modern existence. In the educational domain, this technological evolution is particularly salient, as noted by Al-Malaji (2022), who points out that educational technology is witnessing rapid advancements. Innovative tools such as Augmented Reality (AR) and Virtual Reality (VR) have emerged as transformative forces, fundamentally reshaping the educational landscape by converting static learning environments into dynamic, interactive spaces. This transition from resource-poor settings to resource-rich environments enhances the learning experience and fosters greater engagement among students.

Among these technological advancements, AR technology stands out as a pivotal development in the integration of technology into education (Kumar & Gorai, 2025). Salama (2019) articulates that AR represents a form of interactive learning that not only captivates learners but also ensures the relevance of educational content to their needs and aspirations. This technology merges electronic images with various multimedia elements, including videos, audio clips, animations, and 3D graphics, creating an immersive educational experience that enhances understanding, particularly for complex concepts. Al-Husseini (2014) elaborates on this notion, explaining that AR blends real-world and virtual elements, allowing learners to interact with their environment in innovative ways. This integration of technology into the educational framework introduces a new dimension to teaching, distinguishing it from traditional methodologies.

In tandem with AR, Virtual Reality (VR) has evolved as a significant educational technology. Its origins can be traced back to early experiments aimed at creating immersive experiences. Al-Hila (2014) discusses the historical context of VR, noting its roots in the development of photography and early attempts to create three-dimensional illusions. A pivotal moment in the evolution of VR was the invention of the "Sensorama" by Morton Heilig in 1962, which sought to enhance the immersive experience by combining visual projections with sensory stimuli such as scents and wind. As defined by Al-Malaji (2022), VR is a modern educational technology that simulates environments through computer-generated information, allowing users to engage with these environments through visual and auditory senses. This capability to create realistic simulations opens new avenues for experiential learning, enabling learners to explore and interact with content in ways that were previously unimaginable.

The integration of AR and VR technologies into e-learning frameworks is not merely a technological enhancement; it is deeply rooted in educational theories that inform their design and implementation (Balalle, 2025). Muslim (2022) posits that these technologies are grounded in constructivist theory, which emphasizes the active role of learners in constructing knowledge through experiences and interactions. This constructivist approach fosters an environment conducive to active learning, where students engage with content in meaningful ways. Additionally, AR and VR technologies align with behaviorist theory, which focuses on using stimuli to motivate learning and encourage responses from learners. Furthermore, these technologies, when

combined with social media, can embody social learning theory in certain situations, as they facilitate collaborative interactions among peers, thereby enhancing the educational experience through social engagement (Çelik et al., 2023).

As educational institutions grapple with the challenges and opportunities presented by the rapid advancement of technology, it is imperative to recognize the transformative potential of AR and VR in reshaping pedagogical practices. The shift toward e-learning necessitates a reevaluation of traditional educational paradigms, prompting educators to explore innovative methodologies that leverage these technologies to enhance student engagement and learning outcomes. The integration of AR and VR into educational settings not only enriches the learning experience but also prepares students to thrive in an increasingly digital world.

In this context, it is essential to address the pressing issue of educational quality, particularly at the primary stage, which serves as the foundational building block in the educational system. Countries worldwide are striving to enhance educational outcomes, and achieving this goal necessitates significant efforts and substantial changes in teaching methods. Mubarrad (2021) emphasizes the necessity for teachers to engage in continuous professional development to cope with the changes and innovations in their scientific and practical lives. This has led to an urgent need to develop the educational process through the integration of modern technologies, which, in turn, requires teachers to continuously enhance their professional skills.

Numerous conferences in the field of e-learning have underscored the importance of training teachers to effectively utilize modern technologies within the e-learning system (Uzunboylu et al., 2025). For instance, the International Conference on E-Learning and Distance Learning (2023), along with the Digital Learning and E-Learning Conference (2023), has all recommended the necessity of developing teachers' skills and abilities to utilize modern technologies in education to enhance the learning environment and adapt to the demands of the knowledge economy. Additionally, studies by Muslim (2022) and Al-Malaji (2022) have stressed the need to consider the future roles of teachers within the e-learning framework to strengthen their prospective roles amid the digital transformation in education.

1.1. Literature review

Augmented Reality (AR) and Virtual Reality (VR) have emerged as transformative technologies in various sectors, particularly in education. These immersive technologies facilitate unique learning experiences by bridging the gap between the real and virtual worlds. AR allows users to engage directly with virtual environments that simulate real life, enhancing interaction and engagement (Ismail, 2023). It merges real-world elements with digital content, creating an interactive user experience that can significantly enrich educational methodologies.

The categorization of AR is essential for understanding its applications. Attar and Kinsara (2015) differentiate AR into two primary types: marker-based AR, which uses identifiable markers for interaction, and marker-less AR, which relies on GPS or image recognition. Further classifications by Feher et al. (2018) and Al-Zahrani (2021) include projection-based AR, recognition-based AR, location-based AR, outline-based AR, and vision-based AR. Each type serves specific educational purposes, allowing for a tailored approach to content delivery that can cater to different learning styles and objectives.

The integration of AR in educational settings presents numerous benefits. Rizq (2017), Al-Zahrani (2021), and Bursali & Yilmaz (2019) highlight that AR stimulates student motivation, enhances engagement, and promotes creativity. The technology fosters a more enjoyable learning environment, addresses the limitations of traditional teaching methods, and aids in the long-term retention of knowledge. Immediate feedback mechanisms provided by AR further enhance the learning experience, aligning with contemporary educational paradigms that prioritize student-centered learning.

Conversely, VR has also made significant strides in educational applications. Cochrane (2016) characterizes VR as a simulated environment that allows users to interact with a three-dimensional space, creating immersive educational experiences without real-world risks. The classification of VR into non-immersive, semi-

immersive, and fully immersive types (Ismail, 2023; Al-Anzi, 2021) illustrates the varying levels of engagement and interactivity available to learners.

Yaqoub (2022) identifies several practical applications of VR in education, including virtual laboratories, virtual rounds, and virtual museums. These applications not only enhance students' conceptual understanding but also provide opportunities for experiential learning that traditional methods may lack. The distinction between AR and VR is crucial; while AR overlays digital information onto the real world, VR creates an imagined environment, thus offering different educational experiences (Ismail, 2023).

The comparison of AR and VR reveals key differences in their functionalities. AR exists within the user's reality and enhances it with virtual elements, while VR transports users to a non-physical location, blocking real-world interactions. Despite these differences, both technologies share the potential to enhance visual stimuli and cognitive processes, as emphasized by Khalaf (2021).

Previous studies have explored the implications of AR and VR in educational contexts. Noguera et al. (2017) found that pre-service teachers in Spanish universities exhibited positive attitudes towards AR applications, which significantly influenced their learning processes. Uygur et al. (2018) reported similar findings among student teachers in Türkiye, highlighting AR's engaging and beneficial aspects. Al-Subaie & Issa (2020) analyzed AR's implementation from teachers' perspectives, suggesting a moderate level of use and the need for increased support for educators. Salar et al. (2020) demonstrated that AR positively impacts focus and emotional engagement among science students.

In the realm of VR, Al-Arini (2018) surveyed student opinions on virtual learning environments, revealing strong usability approval among tech-savvy students. Yaqoub (2022) assessed faculty perceptions regarding the feasibility of VR applications, noting moderate acceptance levels. Pavlin and Suznjevic (2019) highlighted primary student teachers' positive expectations of VR, although concerns about student focus were noted. Muslim (2022) found high acceptance levels of both AR and VR technologies among teachers in Jazan, Saudi Arabia, with no significant differences based on qualifications or experience.

The theoretical framework for this literature review underscores the significance of AR and VR as tools for enriching educational experiences. The studies reviewed indicate a growing recognition of these technologies' potential to enhance learning outcomes, stimulate engagement, and provide innovative teaching methods. The current study aligns with this body of research by exploring teachers' perceptions of AR and VR technologies in public schools in Saudi Arabia and Jordan, thereby contributing to the existing literature and offering insights into the practical implications of these technologies in educational settings.

1.2. Purpose of study

This study aims to explore the perceptions of primary school teachers in Saudi Arabia and Jordan regarding the potential application of Augmented Reality (AR) and Virtual Reality (VR) technologies in education, in light of modern trends and visions in educational technology. It emphasizes the importance of integrating modern technologies into the educational process, as outlined in Saudi Arabia's Vision 2030 and the initiatives of Crown Prince Al-Hussein bin Abdullah for information and communication technology in education. These efforts are part of the increasing commitment to enhance the role of digital technologies in developing the educational process in line with the requirements of the digital age.

In general, the problem of this study can be framed in the following questions: What are the teachers' perceptions regarding the use of AR and VR technologies in public schools in both Saudi Arabia and Jordan? How do the responses of the study sample regarding the employment of AR and VR technologies in public schools differ according to variables such as country, years of professional experience, and educational qualifications?

2. METHOD AND MATERIALS

2.1. Participants

The study targeted primary school teachers from public schools in Mecca, Saudi Arabia, and Amman, Jordan. The total sample consisted of 199 teachers, categorized as depicted in Table 1:

Table 1

Distribution of the study sample by variables

Study Variables	Categories	Frequency	Percentage
Country	Saudi Arabia	104	52%
	Jordan	95	48%
	Total	199	100%
Educational Qualification	Bachelor's Degree	137	68%
	Higher than a Bachelor's	62	32%
	Total	199	100%
Years of Experience	Less than 5 years	41	20%
	5-10 years	71	36%
	More than 10 years	87	44%
	Total	199	100%

2.2. Data collection tool

A descriptive survey method was utilized to investigate the current state of teachers' perceptions regarding the integration of Augmented Reality (AR) and Virtual Reality (VR) in the classroom. This approach aimed to capture both the nature and prevalence of the phenomenon being studied. To fulfill the objectives of the research, a questionnaire was developed to assess teachers' views on the use of AR and VR technologies in public schools located in Mecca and Amman. The questionnaire was informed by prior research and consisted of fifteen structured items designed to elicit detailed responses from the participants.

To validate the questionnaire, it was reviewed by a panel of experts, including faculty members and specialists in educational technology. Their feedback was instrumental in refining the tool, leading to linguistic revisions of certain items. The final version of the questionnaire contained fifteen items.

The reliability of the questionnaire was evaluated using Cronbach's alpha coefficient, which demonstrated a high level of reliability. The overall reliability coefficient for the questionnaire is presented in Table 3, indicating a strong internal consistency with a value of 0.97. Participants were asked to respond to the items on the questionnaire using a three-point Likert scale, which included the options of "Agree," "Neutral," and "Disagree." The responses were categorized into levels of agreement based on the mean score ranges.

- **Agree**: Mean score range of 2.34 - 3.00, indicating a high level of agreement.
- **Neutral**: Mean score range of 1.67 - 2.33, indicating a moderate level of agreement.
- **Disagree**: Mean score range of 1.00 - 1.66, indicating a low level of agreement.

This structured response method allowed for a systematic analysis of the data collected from the teachers regarding their perceptions of AR and VR technologies in educational settings.

3. RESULTS

This section presents the findings related to the two primary research questions of the study: (1) teachers' perceptions of utilizing Augmented Reality (AR) and Virtual Reality (VR) technologies in public schools in Saudi Arabia and Jordan, and (2) the differences in these perceptions based on the variables of country, years of professional experience, and educational qualifications.

3.1. Teachers' perceptions of utilizing AR and VR technologies in public schools

To address the first research question, Table 5 summarizes the frequencies, percentages, means, and standard deviations of the teachers' responses regarding the use of AR and VR technologies in their classrooms. These results provide insight into the overall perceptions of educators in both countries and serve as a foundation for understanding how various factors influence these perceptions.

Table 2

Means and standard deviations of sample responses on employing AR and VR technologies in public schools

Statements	Mean	Standard Deviation	Agree (n)	%	Neutral (n)	%	Disagree (n)	%	Rank
1. Teachers consistently use AR and VR technologies in the educational process	1.75	0.768	40	20.1	70	35.2	89	44.7	11
2. Teachers are proficient in designing lessons with AR and VR technologies	1.80	0.782	45	22.6	70	35.2	84	42.2	8
3. Teachers encourage students to use websites and programs related to AR and VR	1.83	0.802	50	25.1	66	33.2	83	41.7	4
4. Teachers assign practical tasks through websites related to AR and VR	1.82	0.825	53	26.6	58	29.1	88	44.2	5
5. Teachers can perform basic maintenance on AR and VR devices and software	1.80	0.862	58	29.1	44	22.1	97	48.7	8
6. Teachers regularly attend training courses on AR and VR technologies	1.77	0.804	47	23.6	61	30.7	91	45.7	10
7. The Ministry of Education conducts courses to enhance teachers' capabilities in AR and VR	1.78	0.840	53	26.6	50	25.1	96	48.2	9
8. The school provides the necessary equipment for implementing AR and VR technologies	1.87	0.835	56	28.1	56	28.1	87	43.7	3
9. Teachers possess the required skills to utilize AR and VR technologies	1.87	0.844	60	30.2	55	27.6	84	42.2	3
10. Teachers work on developing students' attitudes towards using AR and VR technologies	1.82	0.855	58	29.1	48	24.1	93	46.7	6
11. School administration provides suitable solutions to overcome barriers to using AR and VR	1.81	0.851	57	28.6	49	24.6	93	46.7	7
12. Students have sufficient internet access to effectively use AR and VR technologies	1.77	0.817	49	24.6	57	28.6	93	36.7	10
13. Teachers explain to students how to use AR and VR technologies	1.82	0.835	55	27.6	55	27.6	89	44.7	6
14. Teachers share educational content related to AR and VR with colleagues	1.91	0.854	65	32.7	53	26.6	81	40.7	1
15. Teachers are proficient in using AR and VR-related programs and websites	1.89	0.852	63	31.7	53	26.6	83	41.7	2
Overall Mean for the Theme	1.83	0.604							

This indicates a moderate perception among teachers regarding the integration of AR and VR technologies in the educational process.

Key findings from Table 2 include:

- A significant portion of teachers reported that they do not consistently use AR and VR technologies in their educational practices, with 44.7% indicating a lack of regular use.
- Only 22.6% of teachers felt proficient in designing lessons incorporating AR and VR technologies.
- A majority of teachers (48.7%) expressed uncertainty about their ability to perform basic maintenance on AR and VR devices and software.
- Despite these challenges, 46.7% of teachers indicated they work on developing students' attitudes towards using AR and VR technologies.

The findings suggest that while teachers recognize the potential of AR and VR technologies, there are significant barriers to their effective implementation, including a lack of training, resources, and consistent usage.

3.2. Differences in perceptions based on country, experience, and qualifications

To answer the second research question regarding the differences in teachers' perceptions based on the variables of country, years of professional experience, and educational qualifications, various statistical analyses were conducted.

3.2.1. Differences according to country variable

The differences in perceptions based on the country were analyzed using a T-test, as shown in Table 3.

Table 3

Means, standard deviations, and t-test for teachers' responses toward the use of AR and VR technologies in public schools by country variable

	Group	Count	Mean	Standard Deviation	Degrees of Freedom	T	Significance	Comment
VR Technologies in Public Schools	Saudi Arabia	104	2.141	0.4028	162.37	9.073	0.00	Significant Differences
	Jordan	95	1.478	0.5992				

The results indicate significant differences in the perceptions of teachers from Saudi Arabia and Jordan regarding the use of AR and VR technologies. The significance value ($p = 0.00$) indicates a statistically significant difference ($\alpha \leq 0.05$), with teachers in Saudi Arabia demonstrating a more favorable perception of AR and VR technologies than their Jordanian counterparts. This finding aligns with previous research by Suhair (2020), which identified similar disparities attributed to differences in educational systems and resources available in the two countries.

3.2.2. Differences according to the educational qualification variable

The analysis of teachers' perceptions based on educational qualifications was conducted using a T-test, as summarized in Table 4.

Table 4

Means, standard deviations, and t-test for teachers' responses toward the use of AR and VR technologies in public schools by educational qualification variable

Use of AR and VR Technologies in Public Schools	Group	Count	Mean	Standard Deviation	Degrees of Freedom	T	Significance	Comment
	Bachelor's Degree	137	1.941	0.5334	197	3.859	0.000	Significant Differences
	Higher than a Bachelor's	62	1.567	0.6731				

The results reveal significant differences between teachers with a Bachelor's degree and those with higher qualifications. The significance value ($p = 0.000$) indicates a statistically significant difference ($\alpha \leq 0.05$), favoring teachers with a Bachelor's degree. This finding suggests that teachers with a Bachelor's degree have a more positive perception of employing AR and VR technologies compared to those with higher qualifications. This outcome contrasts with the findings of Muslim (2020), who reported no significant differences based on educational qualifications.

3.2.3. Differences according to years of professional experience variable

The differences in perceptions based on years of professional experience were analyzed using a one-way ANOVA, as presented in Tables 5 and 6.

Table 5

Means and standard deviations of teachers' responses on the use of AR and VR technologies in public schools by years of professional experience

Use of AR and VR Technologies in Public Schools	Less than 5 Years (n=41)	5 to 10 Years (n=71)
Mean	1.295	1.973
Standard Deviation	0.5159	0.4127

From Table 5, the means range from 1.295 to 1.973. Table 6 presents the results of the ANOVA analysis:

Table 6

ANOVA results for teachers' responses on the use of AR and VR technologies in public schools by years of professional experience

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	F Value	Significance	Mean	Standard Deviation
Between Groups	14.478	2	7.239	24.535	0.00	Less than 5 Years	1.295
Within Groups	57.828	196	0.295			5-10 Years	1.973*
Total	72.305	198				More than 10 Years	1.9533*

The analysis revealed statistically significant differences in perceptions attributed to years of experience. The ANOVA results indicated an F value of 24.535, which is statistically significant ($p = 0.00$). Post-hoc analysis using the Scheffé test revealed that teachers with less than 5 years of experience had significantly lower perceptions compared to those with 5 to 10 years and more than 10 years of experience. However, no significant differences were found between the latter two groups.

These findings suggest that teachers with more than 10 years of experience have a more favorable perception of AR and VR technologies than those with less experience. This result contrasts with the studies by Muslim (2020) and Suhair Yaqoub (2022), which found no significant differences based on years of experience.

4. DISCUSSION

The findings of this study provide valuable insights into teachers' perceptions of Augmented Reality (AR) and Virtual Reality (VR) technologies in public schools in Saudi Arabia and Jordan. The results reveal a moderate perception among teachers regarding the integration of AR and VR technologies in educational practices, highlighting both the potential and the barriers to effective implementation. This discussion will analyze these findings in relation to the existing literature and explore the implications for educational policy and practice.

The data presented in Table 5 indicates that a significant portion of teachers do not consistently use AR and VR technologies in their educational practices, with 44.7% reporting a lack of regular use. This finding aligns with previous research indicating that while educators recognize the potential of these technologies, their actual integration into the classroom remains limited (Suhair, 2020). The reluctance to adopt AR and VR may stem from various factors, including insufficient training, lack of resources, and inadequate support from school administrations (Alshammari et al., 2021).

Moreover, the study revealed that only 22.6% of teachers felt proficient in designing lessons that incorporate AR and VR technologies. This lack of confidence in lesson design is a significant barrier to the effective use of these technologies. Research has shown that teachers' self-efficacy is critical for the successful integration of technology in education (Bandura, 1997). The findings suggest a pressing need for targeted

professional development programs to enhance teachers' skills and confidence in using AR and VR technologies.

Interestingly, while a considerable percentage of teachers expressed uncertainty about their ability to perform basic maintenance on AR and VR devices (48.7%), a notable 46.7% indicated that they work on developing students' attitudes towards using these technologies. This dichotomy suggests that teachers may recognize the importance of fostering a positive attitude towards technology in their students, even if they feel ill-equipped to use the technologies themselves. This finding is consistent with the work of Ertmer (1999), who posits that teachers' beliefs about technology can significantly influence their instructional practices.

The second research question aimed to explore the differences in perceptions based on the variables of country, years of professional experience, and educational qualifications. The results indicated significant differences in perceptions between teachers from Saudi Arabia and Jordan, with Saudi teachers demonstrating a more favorable view of AR and VR technologies ($p = 0.00$). This finding corroborates previous research by Suhair Yaqoub (2020), which attributed these disparities to differences in educational systems and resources available in the two countries. The more favorable perception among Saudi teachers may be linked to increased investment in educational technology and infrastructure in Saudi Arabia, as outlined in the Saudi Vision 2030 initiative (Ministry of Education, 2019).

Furthermore, the study revealed significant differences in perceptions based on educational qualifications, with teachers holding a Bachelor's degree exhibiting more positive perceptions than those with higher qualifications ($p = 0.000$). This finding is counterintuitive, as one might expect that higher qualifications would correlate with a greater understanding and appreciation of emerging technologies. However, it may reflect a disconnect between advanced educational training and practical application in the classroom. As Muslim (2020) noted, higher qualifications do not always equate to effective technology integration, suggesting that pedagogical training may need to be more closely aligned with technological competencies.

The analysis of perceptions based on years of professional experience revealed statistically significant differences, with teachers having more than 10 years of experience holding more favorable views of AR and VR technologies compared to those with less experience ($p = 0.00$). This result is consistent with the findings of Suhair (2022), who suggested that experienced teachers are more likely to embrace innovative teaching methods. The greater familiarity and comfort with technology among veteran educators may enhance their ability to integrate AR and VR into their teaching practices, reinforcing the importance of mentorship and collaborative learning opportunities for less experienced teachers.

The findings of this study have important implications for educational policy and practice in both Saudi Arabia and Jordan. First, there is a clear need for comprehensive professional development programs focused on AR and VR technologies. Such programs should not only enhance technical skills but also address pedagogical strategies for integrating these technologies into the curriculum effectively.

Additionally, policymakers should consider increasing investment in educational technology infrastructure to ensure that all schools have access to the necessary resources. This includes providing adequate training for teachers on the maintenance and troubleshooting of AR and VR devices, which could alleviate some of the apprehension surrounding their use.

Finally, fostering a culture of collaboration among teachers can enhance the sharing of best practices and resources related to AR and VR technologies. Encouraging experienced teachers to mentor their less experienced colleagues could facilitate a more supportive environment for technology integration, ultimately benefiting student learning outcomes. In conclusion, while teachers in Saudi Arabia and Jordan recognize the potential of AR and VR technologies, significant barriers to their effective implementation persist. Addressing these barriers through targeted professional development, resource allocation, and collaborative practices will be essential for harnessing the full potential of these innovative technologies in the educational landscape.

5. CONCLUSION

The findings from this study illuminate the nuanced landscape of teachers' perceptions regarding the integration of Augmented Reality (AR) and Virtual Reality (VR) technologies in public schools across Saudi Arabia and Jordan. As educational institutions increasingly seek to harness the transformative power of emerging technologies, understanding the factors that influence educators' attitudes and practices become paramount. This study not only highlights the moderate perceptions held by teachers but also identifies critical barriers that hinder effective implementation. In this concluding section, we will synthesize the key findings, discuss their implications for educational policy and practice, and propose recommendations for future research.

The study revealed a clear dichotomy between teachers' recognition of the potential benefits of AR and VR technologies and their actual usage in the classroom. A significant portion of educators reported infrequent use of these technologies, with 44.7% indicating a lack of regular application in their teaching practices. This finding resonates with existing literature that points to a gap between awareness and implementation. Furthermore, the data indicated that only 22.6% of teachers felt proficient in designing lessons that incorporate AR and VR, underscoring a critical need for professional development in this area.

Moreover, the research unveiled a complex relationship between teachers' perceptions and variables such as country, years of professional experience, and educational qualifications. Saudi teachers exhibited a more favorable view of AR and VR technologies compared to their Jordanian counterparts, which may be attributed to differences in educational investment and infrastructure. Interestingly, the findings revealed that teachers with bachelor's degrees had more positive perceptions than those with higher qualifications, suggesting a potential disconnect between advanced educational training and practical application. Additionally, more experienced teachers demonstrated a greater willingness to embrace innovative teaching methods, reinforcing the importance of mentorship and collaborative practices.

The implications of these findings are profound and multifaceted, calling for a strategic approach to educational policy and practice in both Saudi Arabia and Jordan. First and foremost, the study underscores the urgent need for comprehensive professional development programs that focus specifically on AR and VR technologies. Such programs should not only enhance teachers' technical skills but also equip them with pedagogical strategies for integrating these technologies into the curriculum effectively. By fostering a deeper understanding of how to leverage AR and VR for instructional purposes, educators can transform their teaching practices and create more engaging learning experiences for students.

In addition to professional development, policymakers must prioritize increasing investment in educational technology infrastructure. Access to the necessary resources is a fundamental requirement for the successful integration of AR and VR technologies. This includes not only the provision of devices but also the establishment of robust technical support systems to assist teachers with maintenance and troubleshooting. By addressing these logistical barriers, educational authorities can alleviate some of the apprehension surrounding the use of advanced technologies in the classroom.

Furthermore, creating a culture of collaboration among teachers is essential for fostering an environment conducive to the sharing of best practices and resources related to AR and VR technologies. Encouraging experienced educators to mentor their less experienced colleagues can facilitate the dissemination of knowledge and skills, ultimately benefiting student learning outcomes. Collaborative professional learning communities can serve as platforms for teachers to explore innovative teaching methods, share challenges, and celebrate successes in integrating technology into their classrooms.

While this study provides valuable insights into teachers' perceptions of AR and VR technologies, several avenues for future research warrant exploration. First, longitudinal studies could offer a more comprehensive understanding of how teachers' perceptions evolve as they gain experience and receive professional development. Understanding the trajectory of teachers' attitudes toward technology integration can inform the design of more effective training programs.

Additionally, qualitative research methods, such as interviews and focus groups, could provide deeper insights into the specific challenges teachers face when attempting to integrate AR and VR technologies into

their instruction. Exploring the lived experiences of educators can uncover nuanced barriers and facilitators that quantitative surveys may not fully capture. Moreover, expanding the research to include student perceptions of AR and VR technologies could yield valuable insights into how these tools impact learning outcomes and engagement. Understanding students' perspectives can help educators tailor their approaches to better meet the needs of their learners.

Finally, comparative studies involving other countries or regions could shed light on the global landscape of AR and VR integration in education. By examining the factors that contribute to successful implementation in diverse contexts, educators and policymakers can draw lessons that may be applicable to their own settings.

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