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Extended Reality (XR) Technology in ADHD-Friendly Classroom Design

* **Hebatallah Hamdy Mohamed**

Department of Architecture and Planning, Jubail Industrial College, Royal Commission of Jubail and Yanbu. Saudi Arabia

E-mail:heba_hamdy5@yahoo.com

ORCID: https://orcid.org/0009-0009-6395-0760

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ABSTRACT

The educational environment in elementary schools significantly impacts the learning process, children's physical and mental health, and student achievements. Architectural design plays a vital role in supporting ADHD (Attention Deficit Hyperactivity Disorder) students, creating spaces that promote focus and engagement. This study seeks to discover how Extended Reality (XR) technology transforms classroom design into customizable learning environments. It uses qualitative methodology in collecting data from four schools in the United States to understand the current classroom challenges for ADHD students aged between 6 and 11. Moreover, the research applies a quantitative approach through a comprehensive survey that reveals educators' perspectives on using Extended Reality (XR) as a tool for ADHD-friendly classroom design. The results highlight both enthusiasm and concerns regarding XR implementation. It summarizes the key findings and proposes a roadmap for incorporating XR in classroom layout and the needed infrastructure to enhance the motivation and involvement of learners. To optimize XR for students with ADHD, classrooms should prioritize flexibility, movement, and sensory regulation.

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* Corresponding Author

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1. Introduction

1.1 Background and Context

According to the American Psychiatric Association, "ADHD is a medical illness characterized by variations in brain development and brain activity that impact attention, the capacity to remain seated, and self-regulation," with symptom onset by the age of 12 years (Danielson et al., 2024). ADHD is a chronic neurological disease that shows up in three levels of attention symptoms: (a) Inattention (difficulty focusing), (b) Hyperactivity (excessive movement), and Impulsivity (acting without thinking), and (c) a combined type of Inattention and Hyperactivity/Impulsivity (Danielson et al., 2024; El-Said, 2023). It is important to recognize that the environment inside a classroom can affect how children with ADHD behave; therefore, schools need to create spaces that are supportive for these students. The combination of furniture and classroom design significantly impacts the treatment

of students with ADHD (Alqahtani, 2015). The classroom environment poses several obstacles, including maintaining focus and sitting quietly at a desk, which is generally associated with academic achievement. Elementary school students may exhibit restlessness, fidgeting in their seats, or manipulating their chairs and tables (Barnett, 2017).

1.2 Research Gap and Objectives

The main objectives of the study are to identify challenges for students with ADHD in education, such as overstimulating or under-stimulating environments, high levels of distraction, limited personalized learning approaches, and difficulty maintaining focus on tasks. The study investigates the principles for space and furniture design in educational environments for students with ADHD in elementary schools and uses qualitative and quantitative approaches to propose a roadmap for integrating XR into ADHD education.

The overview structure of the study is shown in Figure 1: (1) introduce design requirements of ADHD-friendly classrooms, (2) review some potential applications of immersive learning experiences, (3) discuss XR applications for ADHD-friendly design, (4) measure educators' perspectives on Extended Reality (XR) as a tool for ADHD-friendly classroom design, and (5) finally, discussion and conclusions.

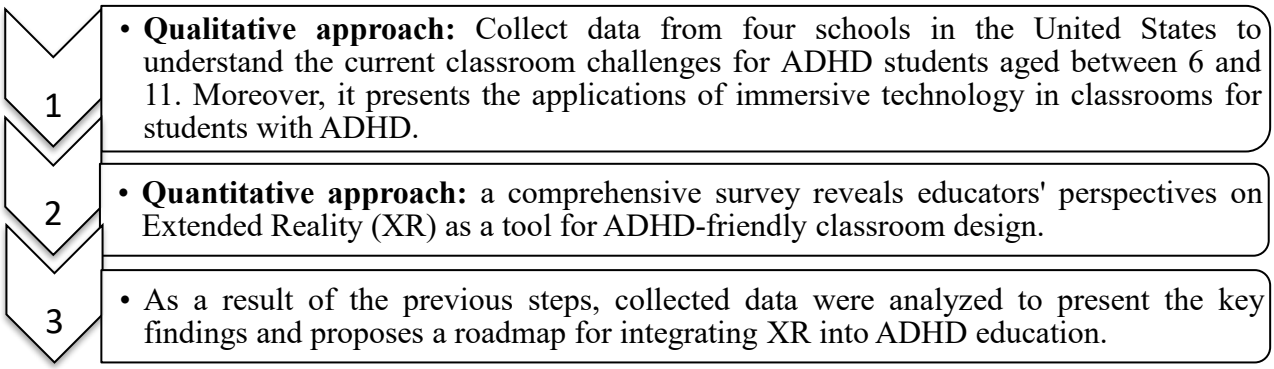


Figure 1. A graphical figure representing the framework and methodology (Developed by Author).

The aim of this study is to explore how Extended Reality (XR) technology transforms classroom design into engaging and supportive environments for students with ADHD by using XR tools. This study focuses on the following questions.
Q1: How do educators perceive XR's potential for ADHD accommodation?
Q2: What specific XR applications show the most promise for ADHD students?
Q3: What barriers exist to wider adoption of XR for ADHD accommodation?

2. Literature Review

Students with ADHD have many academic challenges within the educational setting. Classroom design necessitates the elimination of stimuli and distractions to enhance student attentiveness. Space design in educational institutions should be straightforward and uncomplicated to promote occupants' utilization of the area while preserving the psychology of mobility. (Alkahtany, 2014). The lighting, colors, seating arrangement, and several other variables exert physical and psychological influences on students, reflected in their behavior and performance (Gad et al., 2022).

2.1 Challenges of Students with ADHD in Education

ADHD symptoms contribute to significant behavioral issues, such as aggression and noncompliance, and are associated with academic, social, and emotional challenges. Students with ADHD often have trouble focusing, following instructions, and completing tasks, which can lower academic

performance. Their hyperactivity and impulsivity may disrupt class and strain peer relationships, leading to social conflicts, difficulty maintaining friendships, and low self-esteem (DuPaul et al., 2011; Fidosieva, 2025).

2.2 Design requirements of ADHD Friendly- Classroom

2.2.1 Classroom Layout

Children with ADHD perform more effectively in individual seating arrangements, as they are less distracting than elongated tables. Furthermore, as seen in Figure 2, it is preferable to position them adjacent to the teacher's desk and away from windows or open entrances (location a is better than b). Positioning the child near the teacher or beside attentive and well-behaved peers will increase the likelihood that a student with ADHD will acquire knowledge and maintain focus (Dewitz, 2014). Moreover, this arrangement will inherently promote constructive peer relationships (Alqahtani, 2015). Figure 3 depicts the optimal desk location of students with ADHD in mixed classrooms (Dewitz, 2014).

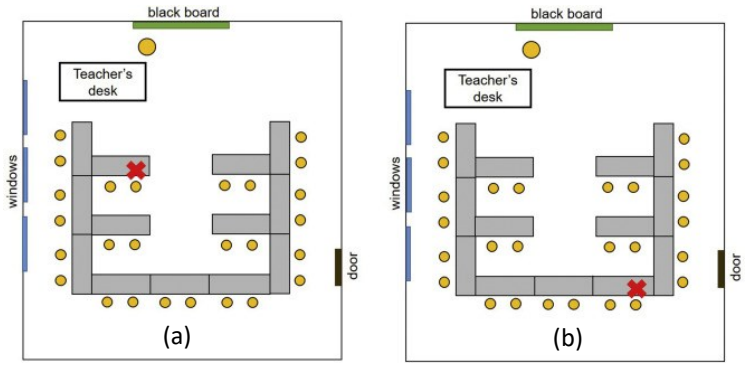
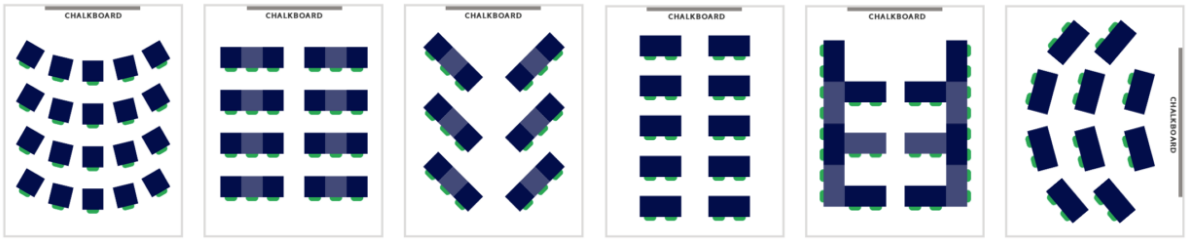


Figure 2. Different seating location in relation to the instructor (Blume, 2018)



a. Room arrangement with individual desks b. Room arrangement with small tables

Figure 3. Desk arrangement for a mix of students with and without ADHD (Dewitz, 2014)

Create a private area in the room for hyperactive students to reduce stimuli while they complete their homework assignments. (Nasrallah, 2023). As shown in Figure 4, a square-shaped space is bordered (on three sides) by bookshelves, with books facing outward to minimize distractions or other obstructions. Additionally, Alqahtani (2015) suggests furnishing classrooms with soft seats and cushions to provide students with a secure and comfortable environment that fosters concentration.

Figure 4. Examples of isolated area in the classrooms (Nasrallah, 2023)

In Figure 5, the classroom configuration includes designated "stations" that enable students to transition between different areas, allowing them to accomplish brief tasks as part of larger projects (Alqahtani, 2015).

Figure 5. Examples of stations in the classroom (Nasrallah, 2023)

2.2.2 Materials, Colors, and Lighting

The lighting, colors, seating arrangement, and several other factors impact both physical and psychological effects on students, seen in their behavior and performance (Frolli et al., 2022). Designers must carefully consider the basic design criteria to be used for people suffering from hyperactivity and distracted attention, such as (a) beauty (shape, joy, and simplicity), (b) materials and techniques (construction and strength), and (c) occupation (comfort, appropriateness, benefit, tranquillity, and order) (Alkahtany, 2014).

1. ***Materials:*** Employing resilient materials throughout the three primary planes of the space helps attain a desired sense of harmony. A delicate link exists between materials and acoustics, essential for mastering soundproofing technology to achieve maximum noise reduction. The use of sustainable resources in interior design has a direct impact on health implications, the environment, and lifetime expenses (Alkahtany, 2014).

2. ***Colors:*** Classrooms have to include a few visual interruptions, such as wall art and decorations, which may affect the educational goals (Nasrallah, 2023). Consistent paint color of the three major planes in the space facilitates self-control, provides a sense of security and greater calm in the space, increases concentration, and eliminates distractions. In general, stick with muted or pastel shades, and avoid primary colors. Each color has a different psychological effect, such as *white* (cold, harsh, and may cause anxiety); *red* (a high-energy color that spikes blood pressure and contributes to stress and aggression); *orange* (encourages creativity and may chase away the blues, and warm earth tones reduce anxiety); *green* (a soothing color that can help to reduce stress and anxiety); and *blue* (is known for slowing down the heart rate, reducing respiratory rhythm, and encouraging calm and focus) (Alkahtany, 2014). In ADHD, the perception of short-wavelength (blue-yellow) stimuli is reduced due to inadequate retinal dopamine, adversely affecting performance on rapid color naming tests that predominantly feature blue-yellow stimuli. (Tannock, 2006)

3. ***Lighting:*** Natural lighting is essential for providing enough light in classrooms to improve morale; lighting should be used indirectly to reduce distractibility (Alkahtany, 2014; Alizadeh et al., 2023). Artificial illumination is important, and ADHD students are highly sensitive to strong light. Lighting classrooms by exposed fluorescent lighting causes inattention and hyperactive behaviors (Alizadeh et al., 2023).

2.2.3 Furniture Design for Students with ADHD

Effective furniture pieces in classrooms must be organized to make the educational experience engaging and enjoyable. When students with ADHD use rigid surfaces, they experience physical pain

that diverts their attention, prompting the necessity to vacate the chair, especially for boys because they are more hyperactive in class than girls (El-Said, 2023; Danielson et al., 2024).

Dynamic seating serves as a strategy to enhance positive classroom behaviors in kids with ADHD, including dynamic seating, therapy balls, pedal desks, and standing desks in Figure 6 (Alqahtani, 2015; El-Said, 2023). Interactive, fidget-friendly classroom furniture designed to assist children with ADHD in performing simple actions like rocking, squirming, and fidgeting alternatives, which promote energy release and enhanced concentration without disturbing others (El-Said, 2023). It attains the most vigorous motion and optimal in-seat conduct. Dynamic seats can be categorized based on children's mobility to strike a balance between facilitating movement and maintaining stability, especially for highly hyperactive children (Stanic et al., 2022).

Wobble chair Therapy ball Ergo seat Standing desk Pedal desk

Figure 6. Examples for dynamic seating suitable with ADHD students (El-Said, 2023)

2.3 Case students for existing schools:

Children with ADHD have received high-quality support in top schools worldwide, with some institutions specifically dedicated to educating students with ADHD and similar challenges. This section highlights four U.S.-based case studies to show the contrast between schools that accommodate ADHD and those that do not. ADHD is one of the most common neurodevelopmental disorders in U.S. children, affecting 11.4% (7.1 million) aged 3–17 in 2022. Diagnosis rates increase with age, from 2.4% in preschoolers to 15.5% in adolescents (Danielson et al., 2024).

2.3.1 Case Study 1: Willow Hill School for ADHD Children, Sudbury

A. Classroom Environment

Children with ADHD have unique needs, requiring individualized classroom settings that allow for one-on-one instruction while accommodating each student. Willow Hill School addresses these needs by designing simple, distraction-free interiors to prevent boredom and restlessness. Visually overstimulating environments and certain colors (like bright orange or stark white) can heighten anxiety in children with ADHD. To counter this, the school uses calming earthy tones such as soft yellow and beige, which help reduce stress and support focus. Moreover, the use of warm lighting over fluorescent lights to reduce anxiety is shown in Figure 7 (Willow Hill School website, 2025; Gad et al., 2022).

Figure 7. Willow Hill school interior (Willow Hill school website, 2025)

Schoolteachers explain that desks are placed away from distractions like doors and windows, with students seated in the center of the room and near the teacher's desk to improve focus. Additionally, limiting desk sharing to one or two students per desk helps maintain attention, as shown in Figure 8 (Willow Hill School website, 2025).

Figure 8. Desk arrangement for classroom in Willow Hill School (Willow Hill school website, 2025)

B. Classroom Furniture

Willow Hill School supports students with ADHD by providing flexible seating options to enhance their learning. These include exercise ball chairs, comfortable wooden chairs, and foot bands shown in Figure 9, which help improve focus and engagement in the classroom (Willow Hill School website, 2025).

Figure 9. Cozy wooden chair with exercise band footsie (Willow Hill school website, 2025)

C. Technology Application inside the classroom

Willow Hill School integrates technology into education by providing each student with a laptop and equipping classrooms with Mimeo Media Systems and Wi-Fi. The school also features a computer lab and library to support technology-based learning, as shown in Figure 10 (Willow Hill School website, 2025).

Figure 10. Technology application in Willow Hill School (Willow Hill School website, 2025)

2.3.2 Case Study 2: Tempa Day School, Florida

A. Classroom Environment

Tampa Day School offers a unique educational approach by supporting inclusive classrooms with individualized attention for students with ADHD. The school emphasizes small class sizes and promotes collaborative learning through various activities, as shown in Figure 11 (Tampa Day School website, 2025).

Figure 11. Tampa Day School interior environment (Tampa Day School website, 2025

B. Classroom Furniture

Tampa Day School is committed to creating an optimal classroom environment by using upgraded furnishings and limiting class sizes to 12 students. Each student has an individual desk and a stable four-legged chair, as shown in Figure 12 (Tampa Day School website, 2025).

Figure 12. Tampa Day School furniture (Tampa Day School website, 2025)

C. Technology Application inside the classroom

Tampa Day School provides each student with a personal iPad, as shown in Figure 13, to support academic learning and develop research skills (Tampa Day School website, 2025).

Figure 13. Technology application in Tampa Days School (Tampa Day School website, 2025)

2.3.3 Case Study 3: Brehm Preparatory School for ADHD, Carbondale, Illinois

A. Classroom Environment

Brehm School conducts the educational experience through a various of methods. Brehm School designs its classrooms to support students with ADHD by closely monitoring their routines. A child with ADHD presents distinct behaviors compared to another child with the same condition; therefore, tailored classrooms that provide one-on-one interaction with the instructor, together with environments accommodating all students, are crucial (Brehm Preparatory School website, 2025).

B. Classroom Furniture

Brehm Preparatory School emphasizes a well-designed classroom interior, advanced technology, and effective teacher communication to enhance student learning, as shown in Figure 14 (Brehm Preparatory School website, 2025).

Figure 14. The interiors of Brehm Prep School (Brehm preparatory school website, 2025)

C. Technology Application inside the classroom

Brehm Preparatory School's one-to-one program provides each student with a laptop equipped with the latest tools and assistive software to support learning, as shown in Figure 15 (Brehm Preparatory School website, 2025).

Figure 15. Technology application in Brehm Prep School (Brehm preparatory school website, 2025)

2.3.4 Case Study 4: Josiah Haynes Elementary School, Sudbury, Massachusetts

A. Classroom Environment

Josiah Haynes Elementary School offers a vibrant, visually engaging classroom environment with colorful decorations and patterned rugs designed to boost student engagement, as shown in Figure 16. However, unlike ADHD-friendly schools, this highly stimulating setting can be overwhelming and distracting for students with ADHD, potentially causing stress and reduced focus. While effective for some learners, the design is less accommodating for those with ADHD (Josiah Haynes Elementary School website, 2025).

Figure 16. Josiah Haynes School classroom (Josiah Haynes Elementary School website, 2025)

B. Classroom Furniture

Josiah Haynes Elementary School uses standard classroom furniture like stackable chairs and movable tables, prioritizing general student needs over individual accommodations, as shown in Figure 17. As a result, it is not classified as a special needs school and may not effectively support students with ADHD (Josiah Haynes Elementary School website, 2025).

Figure 17. Josiah Haynes School classroom (Josiah Haynes Elementary School website, 2025)

C. Technology Application inside the classroom

Josiah Haynes Elementary School emphasizes practical, experience-based learning supported by real-world technology. It integrates various online resources, with Google Workspace for Education serving as a core tool accessible from anywhere (Josiah Haynes Elementary School website, 2024).

2.4 Immersive Learning Experiences:

Learning methodologies are vital and garner specific focus in our lives. Teaching students using traditional learning methods is no longer effective. We reside in the digital era, characterized by a collective need for efficiency, dynamism, rapidity, and interactivity. The interactive methods utilized in pedagogy and in emerging technology education (Pradono et al. 2013). In Technology Based Learning (TBL), teachers help students acquire sufficient core scientific knowledge via technology by presenting a brief video. When effectively applied, technological gadgets and applications can alleviate focus-related challenges and facilitate student engagement in their tasks (Barnett, 2017).

A smart and dynamic learning environment is needed to achieve flexibility, effectiveness, efficiency, engagement, adaptability, and reflectiveness, integrating both formal and informal learning.

Moreover, virtual reality technology cultivates an immersive educational environment that promotes the intellectual development of students with ADHD (Zangiacomi, 2022). These technologies offer a three-dimensional virtual world that enables students to encounter many scenarios that may be challenging or unattainable in reality, hence fostering the development of diverse talents (Parsons, 2007).

Augmented reality (AR), virtual reality (VR), and mixed reality (MR), as shown in Figure 18, are significant concepts in the digital realm. Augmented reality (AR) is a technology that integrates digital components, including photos, videos, text, and animations, with real-world elements, compatible with mobile devices and computers. Virtual reality (VR) is a computer-generated simulation that graphically creates a reality or an alternate universe. Mixed Reality (MR) denotes technology that integrates data from users' surroundings with computer-generated components to merge the physical and virtual realms. (Osorto Carrasco & Chen, 2021).

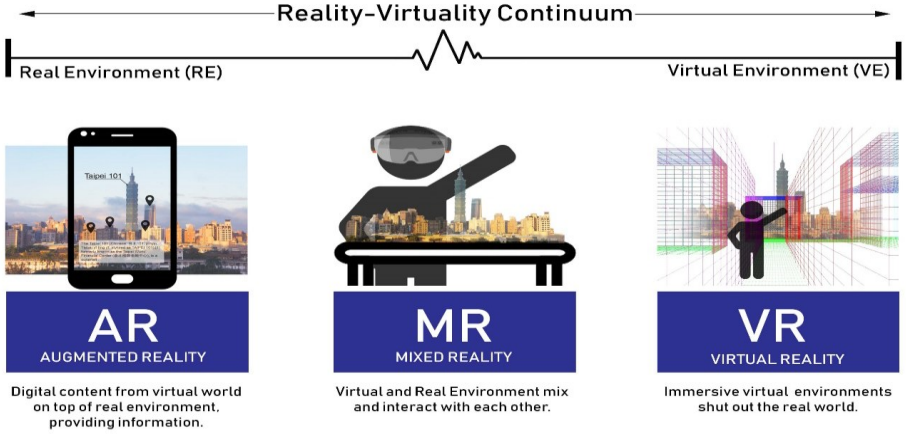


Figure 18. Augmented Reality, Mixed Reality, and Virtual Reality (Osorto Carrasco & Chen, 2021)

Virtual reality is an "embodied technology" that enhances the sensation of presence and immersion, which enables interaction. Virtual reality allows the exploration and manipulation of a particular environment, improving self-regulation and learning by illustrating predictions for internal (body) and external (environmental) sensory inputs. These augment context-specific movements, behaviors, and emotions in virtual agents. These augment context-specific movements, actions, and emotions. It may serve as a hypothesis for intervention with disorders, particularly within the rehabilitation domain. It provides patient-specific stimuli that are consistent, flexible, and controlled. Furthermore, it can reduce mistakes, time, and expenses while enhancing user motivation and improving behavioral and cognitive abilities in youngsters with ADHD. Virtual reality technology enables students with disabilities to engage in experiences that are challenging or unattainable in reality. (Frolli et al., 2022; Zangiacomi et al., 2022).

2.5 XR Applications for ADHD- Friendly Design:

The integration of XR technologies in inclusive education offers enormous potential by providing personalized, adaptable, and engaging learning experiences for all students. XR tools like VR, AR, and MR can address diverse needs, such as simulating real-world environments for students with mobility challenges, offering real-time translations for non-native speakers, and enabling interactive learning for various preferences. These technologies help create inclusive classrooms that support both the challenges and strengths of every learner. (Barbu et al., 2025)

- VR Immersive Learning: VR reduces external stimuli and distractions for tasks requiring deep concentration.
- Interactive AR for task engagement: AR overlays guide attention to key tasks.

- Sensory regulation tools: VR engages multiple senses (visual, auditory, kinesthetic) and reduces sensory overload when needed.
- Personalized learning pacing: VR adapts pacing and customizable avatars to individual needs.
- Gamification for motivation: MR game interface blends physical and digital objects to enhance engagement.

3. Materials and methods

Education is essential for all children, including those with ADHD. While few schools are certified to specialize in ADHD education, some offer tailored programs or adapt conventional curricula through smaller class sizes, individualized instruction, and specialized support. Exploring effective curriculum differentiation strategies for students with ADHD is highly recommended.

3.1 Purpose of the Questionnaire:

The primary purpose of this research is to address the following two questions:

Q1: How do educators perceive XR's potential for ADHD accommodation?
Q2: What specific XR applications show the most promise for ADHD students?
Q3: What barriers exist to wider adoption of XR for ADHD accommodation?

3.2 Research Design

To accomplish the research objective, the researcher examined prior studies, deemed the qualitative method suitable, and adhered to the subsequent stages.

- Literature review to understand the challenges facing students with ADHD and analyze four schools in the United States to identify the key elements affecting classroom design.
- Collecting data through online questionnaires about Extended Reality (XR) as a tool for ADHD-friendly classroom design from educators' perspectives
- Consequently, the collected data was analyzed by the author to present the key findings and propose a roadmap for integrating XR into ADHD education.

3.3 Data Collection

- The study explores how Extended Reality (XR) technologies can support ADHD learners in Middle Eastern educational environments. It examines educators' perspectives on XR's potential to create more inclusive, engaging learning spaces for students with attention challenges.
- The questionnaire was designed using Google Forms. A 5-point scale was used for the Likert scale.
- A comprehensive survey of 327 educators across 8 Middle Eastern countries reveals. Strong representation from the United Arab Emirates (28%), Saudi Arabia (22%), and Qatar (15%).
- School demographics balance between public (53%) and private (47%) educational institutions.

4. Results and Discussions

4.1 Current XR Adoption rates in Middle Eastern classrooms

The survey results show the adoption rates of extended reality (XR) technologies in schools shown in Figure 19, with 42% in the United Arab Emirates, 27% in Saudi Arabia, and 22% in Qatar.

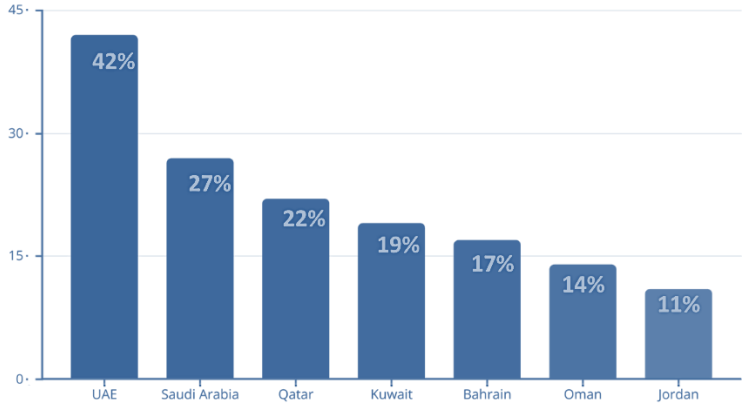


Figure 19. XR adaption rate in the Middle Eastern classroom

4.2 XR application by subject area for ADHD students

XR applications for ADHD students can enhance learning and engagement across various subject areas. Here are some notable applications categorized by subject:

- Science (37% Adoption): Virtual lab simulations, molecular visualization, and ecosystem exploration.
- Mathematics (29% Adoption): 3D geometric manipulations, spatial reasoning tasks, and interactive problem-solving.
- Language Arts (24% Adoption): Immersive storytelling, interactive vocabulary games, and reading comprehension scenarios.
- Social Studies (18% Adoption): Historical recreations, geographic explorations, and cultural immersion experiences.

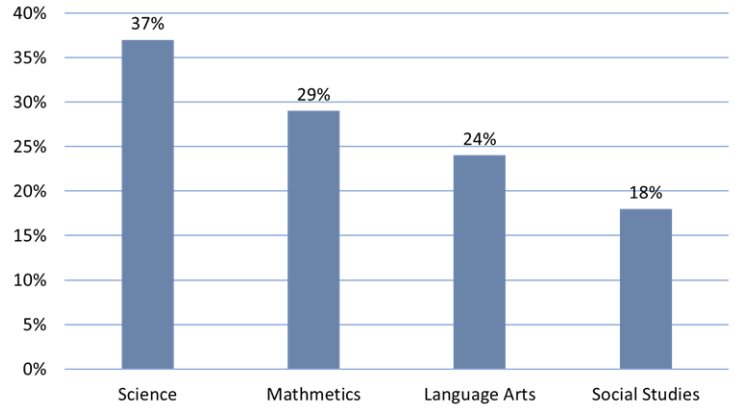


Figure 20. XR application by subject area for ADHD students

4.3 Opportunities from educators' Perspectives

It is clear that the movement in teaching views reflects a larger trend toward student-centered, flexible, and skill-based education. Educators can contribute through (a) creating engagement environments (81% believe XR creates more engaging learning environments), (b) establishing customized programs (72% see potential for customized learning experiences), (c) improving information retention (68% note improvement in information retention), and (d) increasing attention (76% report increased attention spans during XR-based activities).

4.4 XR Challenges and barriers

- Data privacy: Protecting student data.
- Cost concerns: High equipment expenses.
- Teacher training: Educator support and professional development.
- Health: Motion sickness in VR.

- Social balance: Avoid isolation with group activities.
- Sensory Overload: Avoid excessive stimulation.

5. Conclusion

Integrating Extended Reality (XR), which includes Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), into classroom design has the potential to change learning by increasing immersion and interactivity. To accomplish this, educators must consider space, technology, pedagogy, and safety.

The presence of technology in ADHD-friendly furnishings was missing in the four case studies. Incorporating technology into the classroom enhances communication and facilitates academic achievement. Although the integration of technology in the classroom enables students to provide feedback on classes, assume responsibility for their learning, and use their learning objectives. Additionally, participating in projects and educational activities that honor their individuality while acquiring chances and assistance to learn and understand the creative, effective, and safe use of technology (Friedman & Friedman, 2011). Virtual reality serves as an effective instrument for therapy, enabling the development of child-centered and interest-driven rehabilitation activities by boosting motivation within a monitored and safe environment (Frolli et al., 2022).

This study recommends designers incorporate XR in classroom layout for schools specializing in children with ADHD, such as (1) virtual space planning (XR enables teachers to prototype and optimize classroom layouts virtually), (2) AR learning zones (AR creates enhanced zones for learning, guiding students), and (3) VR quiet areas (VR provides quiet spaces for students to focus). Ensure sufficient open space for VR movement, proper lighting for AR/MR sensors, and strong Wi-Fi for seamless streaming. Power outlets and charging stations should be accessible, and acoustics may need adjustments to support immersive audio experiences. An optimized layout might feature an AR-enabled whiteboard at the front, collaborative tables with tablets in the center, and a dedicated VR zone with clear floor space. The back of the room could house charging stations and traditional desks for non-XR work.

Recommendations for Educational Institutions

Implementation requires the following 5 steps: (a) *Assessment* (Evaluate school readiness and infrastructure capabilities for both hardware and software through XR technology adoption), (b) *Teacher training* (Provide comprehensive teacher training and capacity building for effective XR implementation), (c) *Content Development* (Create culturally appropriate XR content specific to Middle Eastern educational contexts). Integration with existing curricula is essential; (d) *Phased Implementation* (Roll out XR technology gradually with continuous feedback and adjustment mechanisms); and (e) *Evaluation* (Conduct data-driven assessment and refinement of XR integration strategies).

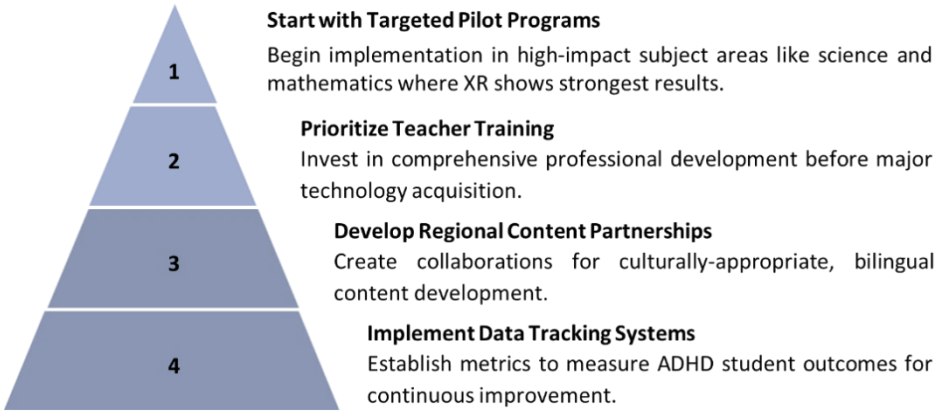


Figure 21. Recommendations for Educational Institutions for incorporating XR in ADHD education

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Ethics Statements
Not applicable (no human/animal subjects were involved).

Conflict of Interests
The Author declare that there is no conflict of interest.

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