Exploring The Effectiveness of Immersive Mobile Learning in Enhancing Stem Subjects

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This study employed a qualitative case study design to explore participants' perspectives on learning STEM subjects through immersive mobile technologies. IML provides learners with immersive experiences and ubiquitous access to educational content using portable devices. The data was collected through focus groups, observations, reflection journals, and interviews in four sessions where students learned physics and chemistry via IML. Findings revealed that IML significantly enhanced student engagement and the motivation to learn STEM and career application, making STEM subjects more concrete and authentic. Participants emphasized the importance of engagement and motivation in STEM learning. This indicates that IML is practical and successful in tackling the challenges of STEM education.

Keywords: Immersive Mobile Learning, Immersive Learning, STEM, Virtual Reality, Augmented Reality.

Introduction

Globally, education systems aim to produce competent learners in STEM fields, and Nigeria is no exception. STEM education drives innovation across healthcare, transportation, and energy (Qureshi & Qureshi, 2021). It cultivates critical thinking, problem-solving, and the development of innovative technologies to address complex global challenges (Poultsakis et al., 2021). This underscores the need for effective STEM teaching to prepare students for present and future challenges across geographical boundaries (U.S. Department of Education, 2016).

One challenge students face in STEM learning is the perceived abstractness of certain subjects. Students often struggle to connect classroom theories to practical, real-world applications (Qureshi & Qureshi, 2021). As technology evolves, immersive learning has been advocated to bridge this gap, making abstract concepts more tangible and engaging.

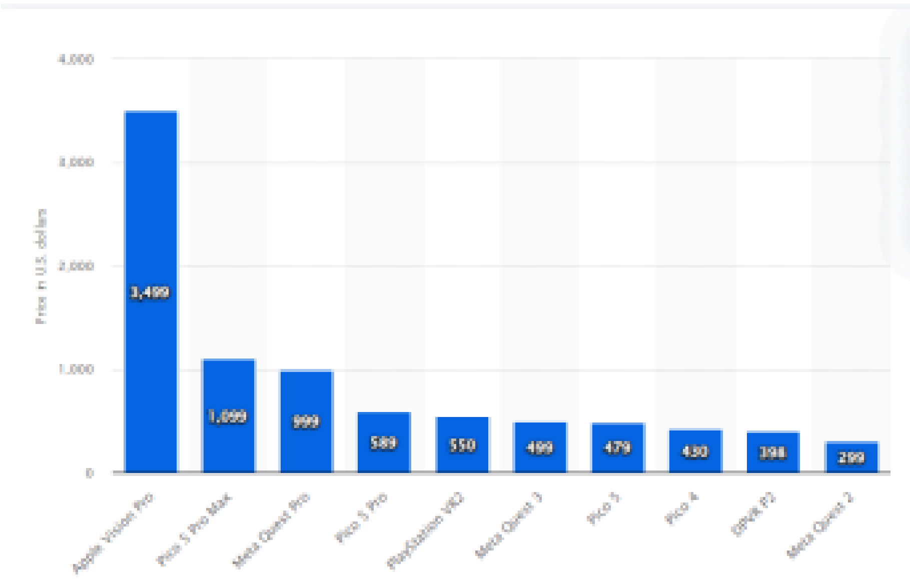
Immersive learning is a broad concept encompassing high-tech and low-tech experiences and deep psychological engagement (MacDowell & Lock, 2023). Agrewal et al. (2020) describe immersive learning as "a phenomenon experienced by an individual when they are in a state of deep mental involvement in which their cognitive processes (with or without sensory stimulation) cause a shift in their attentional state such that one may experience disassociation from the awareness of the physical world" (p. 407).

This phenomenon is akin to entering a mental *bubble* or *flow state*, where the individual is fully immersed in their thoughts, actions, or experiences. Similarly, Dengel (2022) defines immersive learning as "an educational method where artificial experiences perceived as non-mediated are used as learning tools" (p. 1). These methods go beyond entertainment, supporting educational goals, and fostering active engagement.

Augmented reality (AR) and virtual reality (VR) are advancing immersive, hands-on educational experiences. However, in regions like Nigeria, limited access to such advanced technologies due to financial constraints, lack of awareness, or skill gaps poses significant challenges. Despite these barriers, mobile devices offer a viable alternative, being widely available and capable of integrating emerging technologies alongside their primary communication functions (Lin, 2023).

Addressing the challenges in STEM education requires innovative, contextually appropriate learning opportunities. While advanced immersive technologies may be scarce, mobile devices present a promising solution in providing affordable and accessible immersive experiences for Nigerian students. This study focuses on integrating immersive learning through mobile devices, leveraging their capabilities and affordability to enhance STEM education in contexts where traditional advanced technologies are unavailable. By bridging this gap, the study explores how immersive technologies can be effectively implemented to make STEM subjects more engaging and relevant to learners in underserved regions like Nigeria.

Figure 1
Comparison of virtual reality (VR) headsets worldwide in 2024 by price.



Note. Adapted from Comparison of Virtual Reality Headsets (https://www.statista.com/statistics/1337123/vr-headset-comparison-by-price/)

This research examines immersive learning through the lens that significantly emphasizes innovative technological elements, specifically integrating advanced features such as virtual reality (VR), mainly when used with mobile devices. This investigation delves into how these technologies, when harnessed in immersive learning, can potentially transform the educational landscape and enhance the learning experience.

Significance of the study

This study uses a Nigerian high school as a case study to discuss the impact of immersive mobile learning on STEM subjects. Virtual reality (VR) and augmented reality (AR) are examples of immersive technologies with the potential to alter the way we teach and learn significantly. By providing an interactive and immersive learning experience, these technologies offer a unique opportunity to engage learners in ways that traditional teaching methods cannot.

The study highlights the significance of educational technologies in Nigeria, advocating for innovative solutions to improve teaching, learning, and student involvement. Enhancing educational settings and promoting cognitive growth highlights the influence of technology on learning via past knowledge and external circumstances (Kozma, 1994). The findings can assist curriculum developers, education reformers, administrators, and educators in enhancing Nigeria's educational system, encompassing STEM and other areas.

Purpose of the Study

This qualitative case study explores how to provide an immersive learning experience to areas where advanced technologies may be scarce but where mobile devices are abundant. The study seeks new ways of enhancing STEM education with engaging and accessible resources in Nigeria to uptake STEM subjects.

Research Questions

The research questions guiding this study are:

- How do students describe their experiences of immersive mobile learning in school?
- What are students' experiences with exploring STEM subjects using immersive mobile devices?
- Does the use of immersive mobile devices make abstract concepts more real for students than traditional educational resources like textbooks?

Literature Review

Immersive learning is an educational approach that engages learners in deeply interactive and participatory experiences related to the content (Pirker et al., 2020). According to Pagano (2013), "Immersive in the sense that I am 'in' the learning experience, and I am practicing doing the things that I need to do better" (p. 3). It allows educators to create dynamic environments that support deeper learning and facilitate knowledge retention (Gasteiger et al., 2021). Immersive learning encompasses digital experiences, such as augmented and virtual reality, and physical experiences, including hands-on participation through simulations, games, or role-playing (Mystakidis & Lympouridis, 2023). Digital immersion replicates reality using AR, VR, or mixed reality (MR), while physical immersion emphasizes real-world engagement.

Immersive Mobile Learning

Immersive mobile learning (IML) incorporates mobile technologies to provide learners with immersive experiences. Building on mobile learning, which is defined as "learning across multiple contexts, through social and content interactions, using personal electronic devices" (Crompton, 2013, p. 4), IML extends beyond traditional classroom boundaries (Sharples, 2000). It uses mobile devices to deliver educational content and foster authentic and collaborative learning experiences (Cook & Santos, 2016). Buchner and Andujar (2019) describe IML as combining mobile devices with immersive virtual environments, enabling educators to introduce remote or inaccessible locations into the classroom. This approach combines the flexibility and accessibility of mobile learning with the interactivity of technologies like VR, AR, and gamification, offering students engaging, authentic educational experiences.

Impact of Immersive Mobile Learning on STEM Subjects

Recently, immersive technologies such as VR, AR, and MR have transformed STEM education, enabling students to visualize complex concepts and engage in experiential learning, especially with STEM subjects. These technologies enhance student interest, motivation, and content retention while helping bridge the gap in visualizing abstract ideas (Adedokun-Shittu et al., 2020). STEM education is often seen as complex due to the difficulty in conceptualizing abstract concepts and the challenges teachers face in delivering comprehensive curricula with limited resources and time (Feldon et al., 2018; Hamad et al., 2022).

The application of AR in learning environments has shown promising results. For example, mobile augmented reality (MAR) can make STEM content relatable by presenting real-world scenarios with digital enhancements, increasing scientific literacy and engagement (Chiang, Yang, & Hwang, 2014; Wahyu et al., 2020). Research by Kos, Koc, and Yucesoy (2013) demonstrates that AR facilitates better understanding and accessibility of scientific subjects than other e-learning platforms. Similarly, Yildirim (2021) found that AR allows students to "learn by doing," blending real and virtual environments for hands-on experiences. In a study on middle school students learning the "systems in our body" unit, AR made the material more accessible and comprehensive, prompting recommendations to integrate AR features into science materials and textbooks.

In a study, Adedokun-Shittu et al. (2020) explored the impact of AR tools on geography students in Nigeria. Their findings revealed that using an Augmented Reality Instructional Tool (ARIT) improved students' understanding and retention of geographical concepts. The combination of visual and sensory information provided by AR interfaces heightened cognitive access to complex visualizations, resulting in better academic performance. Similarly, Ogbuanya and Onele (2018) studied the impact of virtual reality on Nigerian universities' electrical/electronic technology students. Their results showed that students using VR achieved higher grades than those in the control group, highlighting VR's potential to make learning more engaging and effective.

Challenges and Potential of Immersive Mobile Learning in STEM

Although immersive mobile learning in STEM courses offers numerous benefits, challenges remain. High-quality immersive experiences require substantial investment in technology, instructional design, and content development, making them resource-intensive (Hoang et al., 2019). Additionally, using mobile devices can create distractions, and poorly designed IML environments may lead students to focus on visually appealing but irrelevant aspects instead of the intended learning objectives (Cromley, Chen, & Lawrence, 2023).

Despite these challenges, IML has the potential to revolutionize education by providing flexible, engaging, and personalized learning experiences. Its ability to combine immersive and mobile learning affordances makes it a promising innovation in STEM education, offering significant benefits for fostering deeper understanding and increasing student engagement.

Theoretical Framework

"To say that cognition is embodied means that it arises from bodily interactions with the world" (Thelen et al., 2001, p.1). Embodied schema theory comes from the concept that our understanding of the world is not simply a matter of abstract reasoning and logical deduction but is deeply connected to our physical experiences and environmental interactions (Abrahamson & Lindgren, 2014). Embodied schema theory is a cognitive theory that proposes our knowledge and understanding of the world are grounded in our bodily experiences and interactions with the environment. The core idea is that cognition is embodied, meaning it arises from the unique perceptual and motor skills that come from having a physical body.

Abrahamson and Lindgren (2014) revealed that embodied design principles would enable students to utilize their innate physical instincts and actions to tackle challenges related to STEM subjects by providing students with structured opportunities to enact, visualize, and conceptualize concepts that might be in abstractionism.

Embodied schema theory has important implications for immersive technologies, such as virtual reality (VR) and augmented reality (AR). These technologies aim to create a sense of presence and immersion by simulating realistic sensory experiences, and they have the potential to create powerful embodied experiences that can shape the mental schemas. According to Kontra et al. (2015), embodied learning is likely to be most successful when the learner is actively engaged rather than being a passive observer of the content or watching others interact with manipulatives. By leveraging the principles of embodied schema theory, immersive technologies can enhance students' active engagement in understanding some STEM concepts.

Embodied schema theory is appropriate for this study because provides a theoretical framework for understanding the connection between our physical experiences and cognition, and immersive technologies can leverage these principles to create powerful learning experiences that can enhance our understanding of subjects being taught.

Method

The study adopts the qualitative case study approach to explore how immersive mobile learning can influence learning STEM subjects. According to Creswell and Creswell (2017), a qualitative case study is a qualitative strategy "in which the researcher explores in depth a program, an event, an activity, a process, of one or more individuals" (p.15). For this study, data was collected during the Exploration Phase (data collected during the research), and the concluding phase (data collected to round up the research).

Case and Participants

Case selection is crucial for a case study (Merriam, 1998). This study focused on Nigerian secondary school students aged 13–16 in Senior Secondary School (SS2), equivalent to 11th grade in the U.S. Senior secondary education in Nigeria spans three years and is divided into Science, Arts, and Commercial departments, where students specialize based on future career interests. Science students take STEM-related subjects, Arts students focus on humanities, and Commercial students study business-related topics, with students typically taking 9–12 subjects.

Sampling method

The sampling method adopted for this study is purposeful sampling. Purposeful sampling is a technique employed in research to deliberately select individuals, groups, or elements from a population based on specific criteria or characteristics (Patton, 2002). Purposeful sampling focuses on selecting participants with qualities, experiences, or attributes of interest to the study. This study was chosen deliberately for Senior School Two (SS2) students. This grade level represents individuals who have completed one year of high school and have some prior exposure to high school environments and STEM subjects, thus offering a more informed dataset. I then selected ten students from the three departments: art, commercial, and science of the SS 2 class. Five girls and five boys are among them, ensuring representation across genders and departments.

Description of Data Collection Instruments

Interview. Patton (2002) highlighted interviews as effective for understanding others' thoughts. This study used *focus groups* and one-on-one interviews. The focus group, lasting one hour and 15 minutes, involved ten students in an afterschool classroom setting to encourage collaborative reflection and was video recorded. The *one-on-one interviews*, conducted with five students who attended all sessions, lasted 4 hours and 30 minutes. These semi-structured, open-ended interviews were audio-recorded and securely stored.

Observation. Merriam (1998) emphasized that observational data provide firsthand insight into phenomena. The study involved observing students' interactions with the technologies, participants' dynamics during the STEM lessons, and non-verbal cues during interviews and focus groups to complement verbal responses. Following Emerson et al. (2011), these observations captured behaviors, emotions, and lived experiences while maintaining their essence.

Reflective Journals. Reflective journals were used for students to document their thoughts and experiences after each session, providing a personal space for honest reflection. Emerson et al. (2011) note that personal narratives often adapt to contexts, making journals effective for capturing unfiltered experiences.

Exploration Phase

The exploration phase was operated like an after-school program (a less formal classroom setting) for the 10 selected participants. The after-school program lasted 45 minutes, just like every other class during regular school hours. Students had two classes a week for two weeks, totaling four classes. Students learned topics from chemistry and physics, among the core STEM subjects in Nigerian high schools. Other core STEM subjects include but are not limited to biology, mathematics, data processing, etc. This phase involved a group exploration of STEM content using a mobile VR headset (see Figure 2). This involved using a mobile phone, a virtual reality headset, and the Cospaces edu app. The researchers developed the lesson plans focusing on chemistry and physics topics in the curriculum for the class grade (see Table 1). We also developed one virtual class (Equilibrium of Forces) on the CoSpaces edu app for the immersive component and adapted three existing classes from the app.

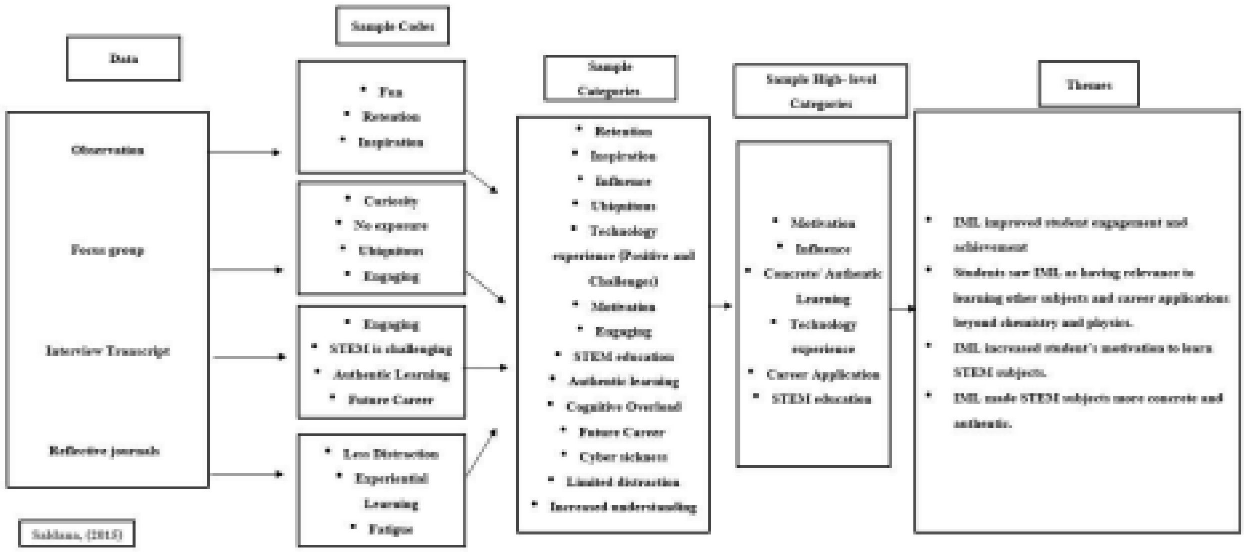
Figure 2
Image of a student using the VR mobile headset.

Note. Image taken by authors.

Data Analysis

The classified codes from all datasets were systematically arranged in Microsoft Excel. Categories were organized in columns, with relevant data arranged in rows, enhanced by color coding to visually link similar categories. This technique enabled the categorization of linked topics, which informed the formulation of overarching themes pertinent to the study objectives see (Figure 3). Clustering related categories revealed patterns and relationships contributing to significant themes that fit the study's aims. We undertook a peer review process to guarantee rigour, engaging in discussions regarding the analysis with a qualitative research expert. This corresponds with Saldaña's (2016) suggestion to sustain consistent communication with reliable individuals during the study process. Peer review offered supplementary insights, guaranteeing thorough investigation and reducing possible oversights.

Figure 3
Stages of Data Analysis



Note. Figure created by authors

Findings

Thematic findings

This section presents the study's findings in themes; the research questions guided the emergence of the themes. Data addressing research questions one to three were collected through interviews, observations, field notes, and reflective journals. The Themes are presented below.

IML improved student engagement and achievement.

Participants' initial encounters with the immersive technology explored highlighted high engagement. The participants all expressed enthusiasm during the exploration phase; common words from their journals when asked to describe their experiences with these technologies were *"fun," "engaging," "interactive,"* etc. In one of the reflective notes, a participant wrote in her reflective journal *"This is a different way of learning entirely, and this is very inquisitive for me."* Participants indicated that immersive technologies like VR (Virtual Reality) made learning more engaging. Referring to the technology, another participant said "*it wanted me to know more, what am I going to see."* It was obvious that these participants found these interactive virtual environments to be dynamic, breaking from traditional classroom settings in a way that
sparked engagement. This theme echoes finding from existing literature (Shi e.tal., 2022; Weng et. al., 2024) that VR's simulative features contributes to optimal engagement, interaction and achievements.

During the classes, it was observed that participants would pause to discuss what they were doing in the space; they would go further to ask questions about their individual progress in completing lessons in the space. This action by the participants showed that they felt more involved in the learning process. According to the focus group, they typically felt passive in class. The flexibility to move around in a virtual space provided engaging learning opportunities.

A good amount of the participants made remarks about actively owning their learning. In one of the classes, as I was packing up the devices, and as students prepared to go home, I paid attention to their conversation. A participant stated *"it was amazing, just me by myself in another space entirely learning."* Similarly, in his reflective journal, a participant wrote *"it does not make learning look like work, when I enjoy something, I will do it with more interest, I will do it better, and I won't* *feel like I'm doing something hard.*" The immersive and hands-on nature of these experiences is seen as an enjoyable way to learn compared to traditional materia. For example, when asked about her experience, participant said, "*I am tired of learning in a normal or traditional classroom. This is a different way of learning entirely, and this is very inquisitive for me…how we were clicking, and moving to understand is very amazing."* These experiences aligns with Johnson et al., 2010; Huang et al., 2016 findings.

Students saw IML as having relevance to learning other subjects and career applications beyond chemistry and physics.

This theme encapsulates how immersive mobile learning experiences apply to subjects other than physics and chemistry explored during the exploration phase. It also shares the possibility of probing into a future career. The students interviewed revealed that immersive mobile learning can help them understand concepts in other subjects.This is reinforced by findings from the current research and a previous study by Makransky and Lilleholt (2018); Capatina et al., (2024). A participant explained:

For example, under projectiles, it would be so easy to understand how a stone is being thrown, the height at which been thrown, the time at which it's coming down, the gravity used, and the velocity. If I should see that, I guess it would be so easy to understand how to answer questions."

While demonstrating how technology can enhance the topics in other subjects, she further stated that " I will also learn in a fun way; I like learning in a fun way." In like manner, another participant shared a similar example but related it to "Organisms", a topic in Biology: *"It would make me understand more for instance if it is used to teach pathogens and organisms, I will understand more."* In addition to participants' ability to apply the use of the technology beyond the subject explored, participants expressed how learning with these technologies can expand learning beyond the scope of the classroom. This relationship was also demonstrated in Zhang's (2023) study revealing the potential of immersive technologies as new learning models.". A participant shared how the space provided the curiosity to want to learn more*:*

"For instance the periodic table, they only taught us 20 elements, it was interesting to see more elements in the device. I saw one element and was amazed about it. It widened my knowledge. I thought they were just 30 elements. It surprised me to know that there are 118 as of now. I enjoyed the class."

When asked "interview question 14," "In what ways can immersive mobile learning help prepare you for future careers?" participants' responses envisioned their career prospects being profoundly enriched by immersive experiences. From their responses, we observed a paradigm shift in their perception, recognizing immersive technologies not solely as recreational tools, but as indispensable assets in shaping their career paths, supporting previous research that virtual worlds can provide immersive learning opportunities for lifelong learners to explore their educational and career options (De Freitas et al., 2010). Discussion on immersive technologies after the exploration phase is now far from the initial (focus group) notion that these technologies were primarily associated with gaming, they now embraced them as dynamic platforms for acquiring practical knowledge, and honing critical thinking abilities. They perceived these immersive technologies as invaluable tools for future career preparation. A few quotes from students includes; " *"If there was simulation for surgeries. I can know what I will be doing in the future. What surgery would look like, I can do some practice. It would make me more confident on what I'm going to expect in the future."* another statement that adds to the notion that such immersive technologies can empower future ambitions is *" it can show me how to mix cement and sand and construct buildings. so, if I use the immersive technology, it would describe how I'm going to do my job and how the drawings are done."* In the same vein, a participant talks about the possibility of exploring her future career in virtual spaces she states *"Using biology as a case study, and I am in a virtual hospital, I can get a glimpse of what my career would look like, which can better inform my choice."* Through immersive technologies, students can have an expansive learning opportunity, and embrace a future career as soon as possible.

IML increased student's motivation to learn STEM subjects.

This theme emerged when participants shared their experiences with their STEM subjects after they explored immersive mobile technologies. The theme reveals the impact of immersive mobile learning on student learning experiences of STEM subjects during and after the exploration phase. This theme is consistent with Parong & Mayer, (2018); Makransky et al., (2019); Makransky et.al, (2020) indicating VR learning is a potential technology that could increase students' interest and motivation to engage in learning. By examining student feedback, distinct experiences that contributed to enhanced motivation were identified. These experiences encompassed better comprehension, reduced distractions, and improved retention, highlighting the beneficial impact of immersive technology on learning outcomes.

Retention (Recall). Through observation during the interview sessions, retention emerged regarding the efficacy of immersive mobile learning in enhancing students' motivation to want to learn. As the dialogue unfolded, it became evident that participants attributed their improved memory retention to the introduced learning method. One student articulated this sentiment; she stated "When you are using the device," she affirmed, her conviction palpable, "whatever you learn sticks to your brain." During interviews, students effortlessly referenced much content from their lessons, seamlessly weaving together disparate concepts—a testament to their enhanced memory retention even without taking notes in class. This seamless recall elucidates the efficacy of immersive learning on their learning experience. The finding aligns with Krokos et al., 2019; Martins et. al., 2024 findings that immersive VR with head-mounted devices increases learning retention and recall.

Increased Comprehension. Many students credited their comprehension of the STEM topic to the immersive and mobile learning components. At one of the sessions, a participant said "*We would be able to understand it more clearly than just explaining it in the normal classroom way. The device would be able to show us.*" She talked about how she always struggled with chemistry, but her experience during the exploration phase was different, she said "*It can benefit me by making me understand my subjects.* Referring to the chemistry lesson she states *"For chemistry too it was so understanding. It was a nice and good learning experience.* Likewise, other participants felt more confident grasping complex topics through the interactive simulations provided by immersive technology. Speaking to generalized concern for science students, one participant recommended that it be strictly adopted for physics since it is their most complex STEM subject; she stated, "*I think we should use it [Immersive technology] more for physics*." This sub-theme indicates that incorporating VR technology into educational tools enhance students' comprehension of subjects they explore, aligning with Manzoor (2022) finding that VR can increase learning motivation.

Less Distraction. Despite the misconception that technology may introduce distractions that dilute students' attention from the lesson, immersive mobile learning enhances students' concentration instead. When talking about using the device, a participant said *"If I'm using the device, as I'm learning, I don't have anyone to disturb me to talk or do any other thing. So, it would be only me, my device, and my eyes without distraction*." The finding is contrary to Parong and Mayer (2020); Mayer et al., (2022) findings that immersive virtual reality learning environments may raise distraction and cognitive load, resulting in less effective learning outcomes. However, in this study, improved concentration and decorum was common to all the participants. A participant related the less distraction to a "*peaceful classroom lesson*"; he stated that, *"It brings more peace to the classroom. If we are working in the classroom there's a distraction when writing, unlike the headset. In a regular classroom, sometimes people start singing, and you will want to feel among by joining them."* The participants valued how the immersive learning environment helped minimize outside distractions and allowed them to focus better on the lesson. In one of the reflective journals, a participant wrote, *"Sometimes we get distracted by our peers or by things happening around us. However, with the device, I will focus and be in charge of my learning."* Participants felt a sense of comfort and concentration during the immersive mobile learning experiences, enabling them to fully engage in the learning process without the typical disruptions in regular classrooms. By providing a controlled and immersive setting for learning, immersive technology enabled the participants to make the most of their learning potential and own their own learning.

IML made STEM subjects more concrete and authentic.

A key aspect of the immersive mobile learning experience was how the immersive devices enabled practical, hands-on learning. This theme align with existing literature on how students acknowledge the valuable impact of immersive technology in creating realistic, hands-on, and experiential environments for exploring complex concepts (Kose 2013; Yildrim, 2021). Students valued the clear and in-depth understanding provided by immersive simulations, especially in subjects like physics and chemistry. Immersive technology helped students better grasp and engage with complex topics in these subjects by visually and interactively representing abstract concepts. This finding is consistent with the literature on how immersive technologies allow students to visualize complex concepts in a controlled yet engaging environment (Adedokun-Shittu et al., 2020). During one of the interviews, a participant remarked that "*...the device helps to show the whole experience. If we were treating it, we would be able to see the parts and everything, the movements and everything on that topic*" Some other comments participants made were: "*We would be able to understand it more clearly than just explaining it in the normal classroom way. The device would be able to show us*," and "*better way for understanding since you can see what you are being taught.*" *"We would be able to understand it more clearly than just explaining it in the normal classroom way. The device would be able to show us.*" The immersive simulations provided a thorough grasp of abstract concepts by allowing students to engage visually and interactively with complex topics. Through authentic learning tasks, students were able to recall prior knowledge and draw meaningful conclusions (Tai & Chen, 2021).

Conclusion

These findings are consistent with the literature on how immersive technologies allow students to visualize complex concepts in a controlled yet engaging environment (Adedokun-Shittu et al., 2020). In the same vein, Immersive technologies for learning have been shown to provide students with the opportunity to engage in simulated, interactive settings where they can participate in genuine learning tasks, aiding them in recalling prior knowledge and drawing relevant conclusions (Tai & Chen, 2021). In the context of the Nigerian educational system, the findings of this study highlight the significance of harnessing mobile technologies that are abundant to provide immersive learning experiences, especially when more expensive headsets are scarce. However, Nigeria's infrastructure issues can hinder student participation in an immersive learning environment. For example, access to dependable internet connectivity is a constant challenge in Nigeria. Although urban areas may have relatively greater access to the internet, rural and underserved areas frequently lack consistent high-speed connections. Internet providers have different data plans and prices, which can pose financial limitations to students if they must be responsible for data, impacting access to high-speed connections.

Implication and Recommendations for Future Research

This study offers insights for educators, policymakers, and governments, highlighting the necessity of incorporating contextually suitable technologies, such as immersive mobile learning, into the curriculum in areas with restricted technology access yet prevalent mobile device usage. Partnerships with local organizations, governmental bodies, and technology companies can enhance access to devices and platforms, while professional development for educators can promote ongoing technology utilization. Strategic alliances can mitigate financial obstacles, fostering fair educational possibilities. Future research should investigate the sustainability of immersive learning, given its swift advancement and the potential neglect of obsolete technologies. Furthermore, research on immersive technologies' financial and sustainability dimensions in Nigeria is crucial. This may entail interviewing essential educational stakeholders to obtain views and develop replicable strategies for enhancing learning accessibility in various circumstances.

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