ISBN: 978-628-96613-3-0. ISSN: 2414-6390. Digital Object Identifier: https://dx.doi.org/10.18687/LACCEI2026.1.1.1595

Emotional and Technological Engagement in Girls' VR STEM learning: Evidence from a Rural Community in Ecuador

Lorena Guachi-Guachi[1]; Giomara Sevilla-Campoverde[2]; Claudia Zuriaga[3]; Pamela Buñay-Guisñan[4]; Guido Mazón[5]; Diego H. Peluffo-Ordóñez[6]; Robinson Guachi[7]
[1,7]Universidad Internacional del Ecuador UIDE, Ecuador, *loguachigu@uide.edu.ec, roguachigu@uide.edu.ec*
[2]Institute for the Future of Education, Tecnológico de Monterrey, México, *giomara.sevilla@tec.mx*
[3]Pontificia Universidad Católica del Ecuador (PUCE Virtual), Ecuador, *cezuriaga@puce.edu.ec*
[4]Universidad Nacional de Chimborazo, Ecuador, *pbunay@unach.edu.ec*
[5]Escuela Superior Politécnica de Chimborazo, Ecuador, *gmazon@espoch.edu.ec*
[6]School of Mathematical and Computational Sciences, Yachay Tech University, Ecuador, *dpeluffo@yachaytech.edu.ec*

Abstract*– Immersive Virtual Reality (VR) has emerged as a transformative tool in Science, Technology, Engineering, and Mathematics (STEM) education, offering new pathways for student motivation, engagement, and conceptual exploration. Nonetheless, limited research addresses how learners from vulnerable communities, particularly girls, emotionally and behaviorally respond to VR-based immersive learning. This study introduced a novel model to represent the pathway Technology Acceptance → Emotional Engagement → Re-Engagement Intention within a short VR-STEM activity conducted among girls (N = 11, ages 8–18) from rural Colta, Ecuador. Using the Meta Quest 3 headset, participants completed two structured sessions ("Oasis Home" and "First Steps – Dancing Robot"). Emotional assessments were collected before, immediately after, and one-hour post-immersion. Results revealed a rise in Excited emotions (20% → 80%), absence of confusion or boredom, and strong re-engagement intention (93 – 100%). These findings underscore the potential of intuitive, emotionally positive VR experiences to promote sustained engagement among girls in underserved settings, informing the design of inclusive VR-STEM frameworks.

***Keywords*-- STEM education, gender equity, immersive learning, socioeconomic vulnerability, emotional engagement, technology acceptance.**

I. Introduction

In recent years, the rapid integration of immersive technologies into STEM education has transformed how students perceive, engage with, and construct understanding of complex scientific concepts [1], [2], [3]. Virtual Reality (VR) environments provide embodied and multisensory experiences that enable students to inhabit virtual worlds, manipulate objects in three-dimensional space, and experience situations that would be inaccessible in conventional classroom settings. These affordances align with constructivist and experiential learning theories, emphasizing learning-by-doing and emotional immersion [4].

Meta-analytic evidence confirms the educational potential of immersive VR. Authors in [4] reported moderate positive effects (Hedges' g = 0.33) on STEM learning outcomes, especially when active learning and interaction were embedded in VR activities. Similarly, systematic reviews demonstrate VR's ability to enhance motivation, spatial understanding, and retention across scientific disciplines [1], [2], [3], [5]. However, the majority of these studies focus on technologically literate or well-resourced populations, leaving a critical knowledge gap regarding learners in marginalized or resource-limited environments [6], [7].

Addressing gender inequality remains a particularly urgent issue. UNESCO data revealed that women represent less than 30% of the world's STEM workforce, and participation rates are even lower in rural and low-income regions [8]. The challenge extends beyond access to technology—it encompasses affective engagement, self-efficacy, and cultural perceptions that shape how girls relate to science and technology [9]. VR has demonstrated unique promise in this regard: its immersive nature can elicit strong emotional responses, increase presence and curiosity, and foster identification with scientific roles [7], [10]. However, how these emotional processes translate into sustained motivation, particularly for girls from socioeconomically vulnerable contexts, remains underexplored.

Existing research has largely emphasized cognitive gains, usability, or technological performance, devoting less attention to the affective and motivational mechanisms that represent technology adoption and sustained engagement [5], [11], [12], [13]. Studies on VR learning frequently invoke theories of presence and flow to explain user experience; however, few have explicitly modeled the connection role of emotional engagement or learners' intention to continue learning following VR exposure [7]. Moreover, most VR-STEM interventions have been conducted with older or university-level learners in well-resourced settings, overlooking how novice users in low-infrastructure environments may respond differently due to limited technological familiarity and socio-cultural constraints [14], [9], [7]. Addressing this bias is essential for developing inclusive and equitable VR-STEM education, ensuring that immersive technologies empower rather than exclude learners from marginalized and underserved communities.

In this study, we introduce a simplified model: *Technology Acceptance → Emotional Engagement → Re-Engagement Intention*, to investigate the affective and motivational dynamics underlying a VR-STEM learning activity involving girls aged 8 – 18 from a rural community in Ecuador.

The first construct, Technology Acceptance, was grounded in the well-established Technology Acceptance Model (TAM) [10] and its subsequent adaptations for immersive and technology-enhanced learning environments. Authors in [15] and [9] demonstrated that learners' perceptions of usefulness, ease of use, system quality, and task–technology fit are critical determinants of their intention to adopt and persist with VR in educational settings.

The second construct, Emotional Engagement, was inspired on [7], which evidenced the central role of affective dimensions (such as curiosity, excitement, presence, and joy) in shaping meaningful and memorable VR learning experiences. Emotional responses are often more pronounced in immersive environments than in traditional instructional settings. Emotional responses tend to be more intense and immersive compared to traditional educational settings, contributing directly to learner motivation and satisfaction. For instance, a recent study on VR field trips in STEM education reported that feelings of awe, curiosity, and enjoyment substantially enhanced students' intrinsic motivation and engagement, reinforcing the importance of emotional activation in immersive educational design [7].

The final construct, Re-Engagement Intention, represented the learner's behavioral readiness to continue exploring STEM topics after the VR intervention. This dimension is particularly critical in vulnerable or resource-constrained contexts, where sustaining motivation beyond the initial exposure can be challenging.

II. METHODOLOGY

A. Virtual Environments

Two immersive virtual environments available on the Meta Quest 3 headset (*Oasis Home* and *First Steps*) were selected as the orientation and interactive spaces, respectively. The choice of these environments was guided by prior research recommending a structured, staged approach to VR exposure: beginning with a low-interaction orientation phase to help users adjust and minimize disorientation, followed by a more interactive phase designed to enhance engagement and learning. Studies have shown that the inclusion of clear spatial boundaries, visual cues, and gradual exposure significantly reduces spatial disorientation, particularly during initial interactions with head-mounted displays [16], [17]. Furthermore, systematic reviews in educational contexts indicate that VR designs, in which a familiarization phase precedes active exploration, effectively enhance presence, emotional engagement, and usability, especially for novice learners [6], [18].

B. Participants

This study was carried out at two research-oriented schools in Colta, Ecuador, with the voluntary participation of 11 girls aged 8–18 years. None of the participants had prior experience with virtual reality technologies. Informed consent was obtained from parents or legal guardians before data collection.

C. Procedure

This study involved four phases, summarized in Fig. 1. All immersive sessions were conducted individually in a private setting using portable Meta Quest3 headsets, with a trained technician providing continuous guidance and support. A context-sensitive research instrument was developed to ensure cultural and linguistic appropriateness, incorporating brief questions administered after each phase to capture participants' *Emotional Engagement*, *Technology Acceptance*, and *Re-Engagement Intention*, as detailed in Section II-D.

1) Baseline Emotional State (BES – 30 minutes before immersion: Participants self-reported their initial emotional state (*Bored, Relaxed, Excited, Curious, Uncertain, Confused*) in a calm, non-technological setting to establish affective baselines, using the *Emotional Engagement* component of the research instrument, as described in Section II-D1.

2) Immersive Session 1 (IS1) – First Contact (1 minute, Oasis Home): Participants explored the *Oasis Home* environment to become familiar with gaze and motion controls within a calm, virtual home setting. During this orientation phase, they were encouraged to look in multiple directions (right, left, up, and down) and take up to three small steps forward to ensure comfort and spatial awareness. The technician provided minimal verbal guidance, intervening only when necessary to preserve a sense of autonomy and presence.

At the end of IS1, participants self-reported their emotional state and responded to **Question IS1:** "*After the adventure, would you like to visit other places like the ones we saw in this adventure?*", as described in Section II-D1 and Section II-D2.

3) Inmersive Session 2 (IS2) – Active Interaction (2 minutes, First Steps – Dancing Robot): Participants entered the *First Steps* virtual world, where they interacted freely with a dancing robot. The activity encouraged physical engagement, curiosity, and emotional activation through embodied play. During this immersive session, the technician asked two short, open-ended questions — *"What are you seeing?"* and *"What do you like about what you are seeing?"* — to monitor participants' well-being and immediate affective reactions. These questions were designed to promote verbal reflection and reduce potential anxiety among first-time VR users, particularly children and participants from low-technology exposure contexts.

At the end of IS2, participants self-reported their emotional state and responded to **Question IS2:** *"Would you like to do something similar when you grow up?"*, as described in Section II-D1 and Section II-D2.

4) Sustained Emotional Response (SER – 1 hour after immersion): One hour after the session 2, participants again selected their dominant emotion (as described in Section II-D1) to assess sustained affective engagement beyond the immediate novelty of the VR experience.

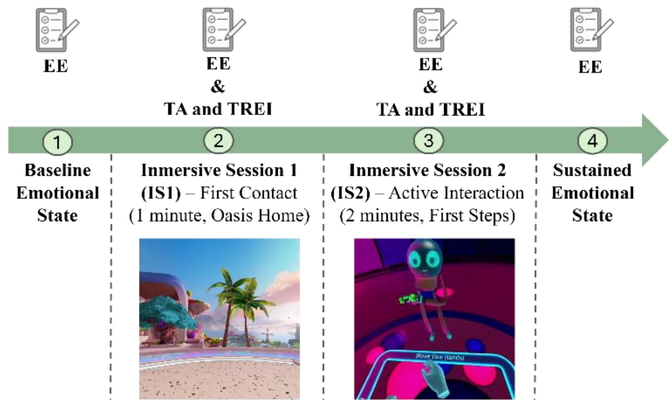


Fig. 1 Overview of the experimental procedure illustrating the four sequential phases. EE: Emotional Engagement. TA and TREI: Technological Acceptance and Re-Engagement Intention.

D. Research Instrument

We used two complementary, context-specific components to capture participants' *emotional engagement*, *technological acceptance*, and *re-engagement intention*.

1) Emotional Engagement: Four lists of visual stickers representing five discrete emotions (***Negative****: Bored; Neutral: Relaxed;* ***Positive****: Excited, Curious;* ***Complex****: Uncertain, Confused*) were used in each phase to assess participants' self-reported emotional states. This non-verbal approach aligns with affective evaluation methods applied in immersive learning research, particularly with children and novice VR users, where visual-emotional indicators improve comprehension and accessibility [9]. Although discrete emotion categorization is less sophisticated than continuous affective models, it offers a practical and ethical approach for preliminary studies involving young or first-time VR users. This categorical approach facilitates comprehension and minimizes participant fatigue, especially in contexts where psychometric or physiological tools may not be feasible [19], [20]. Discrete self-reports have been effectively applied in exploratory VR education and emotional engagement studies to capture baseline affective patterns before transitioning to multidimensional or continuous emotional scales [9].

- *Bored* represented a negative affective state often associated with disengagement or low stimulation, typically emerging when instructional materials lack relevance or challenge.
- *Relaxed* reflected a neutral and comfortable affective state, interpreted as a condition of emotional safety and cognitive readiness.
- *Excited* denoted a high-arousal, positive-valence emotion that emerged as a primary marker of *Emotional Engagement*. Excitement in immersive learning is associated with motivational activation, intrinsic interest, and perceived enjoyment.
- *Curious* represented a reflective and exploratory positive emotion, often linked to cognitive engagement and the pursuit of new information.
- *Uncertain* was classified as a complex emotion, reflecting moments of cognitive disequilibrium that may precede curiosity or problem-solving behaviors.
- Confused, in contrast, represented a disorienting or negative cognitive-affective state typically arising from usability issues or cognitive overload.

2) Technological Acceptance and Re-Engagement Intention: Following the *Oasis Home* and *First Steps* immersive sessions, participants were asked one brief, age-appropriate question in each phase: **Question IS1** and **Question IS2**, respectively.

Question IS1: After the adventure, would you like to visit other places like the ones we saw on this adventure?

- Yes! I want to learn more and do things like that.
- Maybe, if they explain it to me more.
- No, it doesn't interest me.

Question IS2: Would you like to do something similar when you grow up?

- Yes! I want to visit other places. I want to learn more.
- No, I prefer to do other things.

These questions were designed to evaluate participants' perceived enjoyment, interest, and behavioral intention to continue exploring VR environments. They were inspired by the constructs of *perceived enjoyment* and *behavioral intention* from the Technology Acceptance Model (TAM) [10], and developed in accordance with methodological recommendations for inclusive education research, which emphasize the value of concise, contextually relevant questioning to enhance linguistic clarity and cultural accessibility for participants [21], [22], [23].

E. Proposed Model of VR-STEM engagement

The interpretation of data in this study was grounded in the proposed model *Technology Acceptance → Emotional Engagement → Re-Engagement Intention*, which integrates elements of the Technology Acceptance Model (TAM) [10] and the emotional connection frameworks proposed for immersive learning environments [9].

1) Technology Acceptance: Technology acceptance was inferred from the absence of negative effects such as confusion or frustration during the virtual experience. According to TAM [10], perceived ease of use and perceived enjoyment are critical precursors to learner engagement in digital environments..

2) Emotional Engagement: Emotional engagement was assessed through changes in positive emotions (*Excited* and *Curious*) across immersion phases, confirming technological acceptance into deeper involvement and interest.

3) Re-Engagement Intention: Re-engagement intention was inferred from participants' affirmative responses to post-immersion questions expressing a desire to continue exploring or learning through VR. This construct reflected the behavioral intention dimension of TAM and within this study, high re-engagement scores indicated that emotional activation effectively translated into the willingness to persist in STEM-related exploration.

III. Results

A. Technology Acceptance

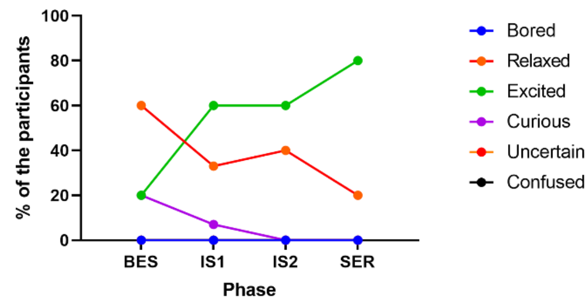
Across all phases, none of the 11 participants reported *Confused* or *Bored* emotions, indicating high levels of comfort with the headset and interfaces. This absence of negative affect demonstrates that the immersive environments (*Oasis Home* and *First Steps*) were intuitive and enjoyable even for first-time VR users, supporting the construct of *Technology Acceptance*.

During *IS1*, although initially shy, participants watched attentively as the technician demonstrated how to use the VR headset. They showed excitement and eagerness to try it themselves, even assisting the technician in properly placing and removing the headset when it was their turn. While immersed in the *Oasis Home* environment, participants confidently described what they observed, using phrases such as "I like the colors", "I like it", "I see a city with many buildings", "It is a nice place", "I like the landscape", "I see a river, a house".

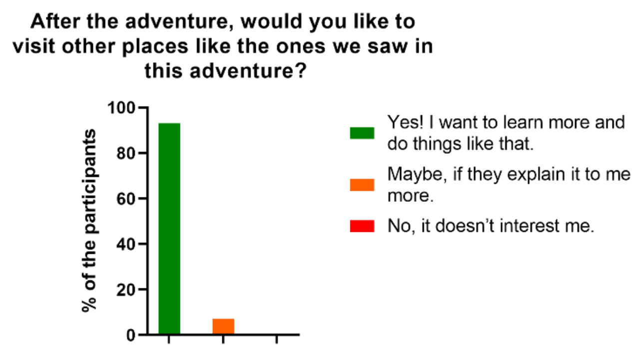
During *IS2*, immersion in the *First Steps* environment, ten of the eleven participants made small body, and/or arm movements, following the actions of the robot. Seven participants smiled and described the experience by saying "There is a robot that dances", while nine expressed excitement with phrases such as "I want to play a little longer" when the technician asked whether they wished to continue or finish the activity, further demonstrating their acceptance and enjoyment of the technology.

B. Emotional Engagement

Fig. 2 illustrates the distribution of emotions across the four phases. The initial *Baseline Emotional State (BES)* revealed predominantly neutral affect (*Relaxed* = 60%), with smaller proportions of *Excited* and *Curious* (20% each). Following the first immersion in *Oasis Home* (IS1), the proportion of participants reporting *Excited* increased to 60%, accompanied by a decrease in neutral states (*Relaxed* = 33%). During the interactive phase in *First Steps – Dancing Robot* (IS2), *Excited* remained stable (60%) and persisted at 80% one-hour post-session (*Sustained Emotional Response – SER*).



(a)



(b)

(c)

Fig. 2 Emotional distribution and re-engagement responses across experimental phases: a) Emotional changes across immersive sessions (BES-IS1–IS2–SER); b) re-engagement intention after IS1; c) re-engamente intentaion after IS2. BES: Baseline Emotional State. IS1: Inmersive Session 1. IS2: Inmersive Session 2. SER: Sustained Emotional Response.

The progressive dominance of positive emotions across phases demonstrates a strong increase in *Emotional Engagement*, consistent with prior evidence that affective activation—particularly excitement and curiosity—predicts deeper cognitive engagement and motivation in immersive learning contexts [9].

C. *Re-Engagement Intention*

Responses to the post-immersion questions further supported the positive emotional trajectory. After IS1 (*Oasis Home*), 93% of participants selected *"Yes! I want to learn more and do things like that"*, while the remaining 7% selected *"Maybe, if they explain it to me more"*. After IS2 (*First Steps – Dancing Robot*), all participants (100%) expressed affirmative re-engagement intention *("Yes! I want to visit other places. I want to learn more")*. No negative responses were recorded.

These results indicate a complete transformation from neutral baseline affect to enthusiastic re-engagement intention, supporting the sequential influence of acceptance and emotion on behavioral motivation as described in TAM-based immersive learning research [10].

D. *Model Alignment*

The results empirically align with the proposed model *Technology Acceptance → Emotional Engagement → Re-Engagement Intention*. Participants' smooth adaptation to the VR interface (high acceptance) led to increased excitement and curiosity (emotional engagement), which, in turn, translated into unanimous interest in further exploration (re-engagement intention).

This sequential pattern validates emotional engagement as a behavior between technology use and sustained motivation, consistent with prior immersive learning findings [9].

IV. DISCUSSION

This study contributes to the VR-STEM literature through both conceptual and methodological originality. It proposed and empirically supported a simplified integrative model: Technology Acceptance → Emotional Engagement → Re-Engagement Intention, applied to a population that remains largely underrepresented in immersive learning research: girls from a rural, socioeconomically vulnerable context with no prior VR experience. In contrast to prior studies emphasizing cognitive outcomes or system performance in well-resourced settings, this work foregrounds affective engagement as a central mechanism driving sustained motivation. Methodologically, the use of context-sensitive, low-complexity emotional assessment tools (i.e., visual sticker-based self-reporting) provides a practical and ethically appropriate approach for capturing affective responses among young, novice participants in low-infrastructure environments. Collectively, these contributions support the proposed VR-STEM engagement model and provide relevant implications for research and practice in socially vulnerable female populations.

Consistent with the first component of the proposed model, the high levels of technology acceptance observed among participants, despite their lack of prior VR experience, suggested that when VR technologies are introduced in a supportive and gradual manner, learners from under-resourced settings can readily adopt and engage with them. This finding aligns with TAM-based evidence [15], [9] which identifies perceived ease of use and task–technology fit as key predictors of adoption and sustained usage. Accordingly, the design and implementation of VR-STEM interventions should emphasize accessibility, user-friendly interfaces, and structured pre-immersion orientation to build confidence and reduce cognitive load.

The emotional engagement observed, especially the rise in excitement and the absence of confusion or boredom, provided insights into the affective affordances of immersive VR for this population. These results are consistent with VR interventions, as reported in [18], showing that VR can significantly enhance social and emotional learning among children and adolescents. Likewise, research in immersive STEM education highlight VR's unique ability to evoke curiosity, awe, and intrinsic motivation as key emotional precursors that drive deeper cognitive engagement and promote sustained re-engagement in learning processes [7], [6]. Thus, when designing VR-STEM experiences for vulnerable or novice learners, it is crucial to prioritize enjoyable, emotionally positive, and exploratory interactions over purely content-driven tasks.

The strong behavioral intention to re-engage with STEM observed after the VR sessions is particularly promising in contexts where maintaining long-term interest often presents a challenge. The sequential progression from technology acceptance to emotional engagement and ultimately to re-engagement intention validates the proposed model and suggests a replicable design pathway for immersive learning. These results pave the way for the implementation of multi-phase VR-STEM interventions, beginning with familiarization and low-stakes orientation, advancing to active and emotionally engaging interaction, and concluding with reflective prompts that encourage learners to envision future exploration within STEM.

Despite these promising findings, several limitations should be considered. Our study assessed emotional engagement one hour after the VR intervention. However, it is essential to note that longer-term follow-up would be needed to evaluate the persistence of re-engagement and the potential development of STEM identity formation over time. Prior research in VR and STEM education suggests that while immersive experiences can effectively enhance intrinsic motivation, their impact on long-term beliefs, self-efficacy, and sustained engagement may be limited without an appropriate and continued support [7]. Moreover, the small sample size and specific demographic context (girls aged 8–18 in one rural community) restrict the generalizability of the findings. Nonetheless, these preliminary results provide valuable insight into the emotional and motivational dynamics of first-time VR users in vulnerable settings and represent an important step toward the design and implementation of scalable, multi-phase VR-STEM interventions that foster both short-term excitement and long-term engagement. Future research should therefore prioritize longitudinal designs with larger and more diverse samples to evaluate the persistence of emotional engagement and its translation into sustained educational outcomes.

From an inclusive design perspective, the findings highlight that accessibility and emotional response are key drivers of effective VR-STEM learning experiences. For learners in vulnerable contexts, the pathway to sustained STEM re-engagement may not purely rest on content mastery, but on creating experiences where learners feel capable and excited and see a clear continuation in the STEM pathway. Educators and designers should integrate VR sessions with follow-up activities such as peer discussion, reflection, next-step challenges, to turn initial excitement into sustained engagement.

Building on these practical implications, further work is also needed to refine the measurement of affective engagement. While discrete emotional categories proved effective in this exploratory context, integrating multimodal approaches, such as physiological measures, behavioral tracking, or continuous affective scales, would enable more granular analysis. Moreover, comparative studies examining different VR designs, levels of interactivity, and the inclusion of collaborative or social learning elements are also recommended. Finally, extending the proposed model to incorporate constructs such as self-efficacy, STEM identity, and perceived career relevance may provide a more comprehensive understanding of how immersive experiences influence long-term participation, particularly among underrepresented groups.

IV. Conclusion

This study reinforces growing evidence that immersive VR can serve as a powerful tool to enhance motivation and emotional engagement in STEM learning among vulnerable and under-resourced female populations. By validating the pathway Technology Acceptance → Emotional Engagement → Re-Engagement Intention, it paves the way for a future practical translation of this framework for designing inclusive VR-STEM interventions that go beyond content delivery to ignite sustained curiosity and participation. The findings suggest that brief, well-designed, and emotionally engaging VR experiences can spark lasting enthusiasm for STEM in contexts where access and confidence are often limited. Integrating usability and emotion as sequential connections provides a promising direction for developing equitable and motivating learning environments. Future research might explore different durations for the immersive VR sessions, the role of peer collaboration, and culturally relevant VR designs, alongside longitudinal tracking of re-engagement and STEM identity development.

Acknowledgment

This study was conducted within the framework of the INSPIRA Project (Agreement No. 81311645), implemented by the Universidad Internacional del Ecuador and funded by the "Fondo de Innovación II" program of the German Cooperation (GIZ-Ecuador). The authors wish to thank A. Pilco, N. Chanatasig, STEM Volunteers and Mentors for their participation in the STEM workshop.

References

[1] T. Tene, J. Alexandra, M. Tixi, M. Salazar, C. V. Gomez, and S. Bellucci, "Integrating immersive technologies with STEM education : a systematic review."

[2] X. P. Lin and B. Bin Li, "The impact of virtual reality on student engagement in the classroom – a critical review of the literature," no. April, pp. 1–8, 2024, doi: 10.3389/fpsyg.2024.1360574.

[3] G. Lampropoulos, *Virtual reality and gamification in education : a systematic review*, vol. 72, no. 3. Springer US, 2024.

[4] J. G. Cromley, R. Chen, and L. Lawrence, "Meta - Analysis of STEM Learning Using Virtual Reality : Benefits Across the Board," *J. Sci. Educ. Technol.*, vol. 32, no. 3, pp. 355–364, 2023, doi: 10.1007/s10956-023-10032-5.

[5] H. Jiang, D. Zhu, R. Chugh, D. Turnbull, and W. Jin, "Virtual reality and augmented reality-supported K-12 STEM learning : trends , advantages and challenges," pp. 12827–12863, 2025.

[6] M. Astatke, C. Weng, and A. Yohannes, "What is the role of immersive virtual reality (IVR) in the development of creativity skills and engagement among students in STREAM (Science , Technology , Religion , Engineering , Art , and Mathematics)- based learning ?," *Educ. Inf. Technol.*, vol. 30, no. 15, pp. 21403–21425, 2025, doi: 10.1007/s10639-025-13610-9.

[7] G. Makransky and R. E. Mayer, "Benefits of taking a virtual field trip in immersive virtual reality: Evidence for the immersion principle in multimedia learning.," *Educ. Psychol. Rev.*, pp. 1771–1798, 2022, doi: 10.1007/s10648-022-09675-4.

[8] UNESCO, "Cracking the code: girls' and women's education in science, technology, engineering and mathematics (STEM) - UNESCO Biblioteca Digital," *Unesco*, p. 85, 2017, [Online]. Available: https://unesdoc.unesco.org/ark:/48223/pf0000253479.

[9] S. Factors, X. Yin, J. Zhang, G. Li, and H. Luo, "Understanding Learner Satisfaction in Virtual Learning Environments : Serial Mediation Effects of Cognitive and," 2024.

[10] F. D. Davis, "Perceived usefulness, perceived ease of use, and user acceptance of information technology," vol. 13, no. 3, pp. 319–340, 1989.

[11] C. Sandor, M. Billinghurst, T. C. Peck, K. A. Mcmullen, and D. College, "DiVRsify: Break the Cycle and Develop VR for Everyone," *IEEE Comput. Graph. Appl.*, vol. 41, no. December, pp. 133–142, 2021, doi: 10.1109/MCG.2021.3113455.

[12] R. Torres-Molina, L. Guachi-Guachi, R. Guachi, P. Stefania, and F. Ortega-Zamorano, "Learning Style Identification by CHAEA Junior Questionnaire and Artificial Neural Network Method: A Case Study," 2020, doi: 10.1007/978-3-030-32033-1_30.

[13] R. Torres-Molina, J. Banda-Almeida, and L. Guachi-Guachi, “Artificial Neural Networks in Mathematical Mini-Games for Automatic Students’ Learning Styles Identification: A First Approach,” 2019, doi: 10.1007/978-3-030-33617-2_6.

[14] J. Mo, “Improving The Middle School STEM Education in Rural China Through Virtual Reality,” vol. 9, pp. 44–51, 2023.

[15] A. T. A. Model, “B ehavioral sciences The Behavioral Intention to Use Virtual Reality in Schools : A Technology Acceptance Model,” 2024.

[16] M. Crespo-Bellido, J. Fernandez Ong, A. Yaroch, and C. Byker Shanks, “E-health Dietary Interventions for Participants of Supplemental Nutrition Assistance Program and Special Supplemental Nutrition Program for Women, Infants, and Children: A Systematic Review,” *Curr. Dev. Nutr.*, vol. 8, no. February, p. 102099, 2024, doi: 10.1016/j.cdnut.2024.102099.

[17] Y. Liu, K. Yue, and Y. Liu, “Behavioral analysis in immersive learning environments : A systematic literature review and research agenda,” 2023.

[18] A. S. Review, F. Zhang, Y. Zhang, G. Li, and H. Luo, “Using Virtual Reality Interventions to Promote Social and Emotional Learning for Children and Adolescents :,” 2024.

[19] R. Plutchik, “The Nature of Emotions Human emotions a fact that have deep evolutionary roots , may explain their and provide tools complexity for clinical practice,” vol. 89, no. 4, pp. 344–350, 2014.

[20] A. Betella and P. F. M. J. Verschure, “The Affective Slider : A Digital Self- Assessment Scale for the Measurement of Human Emotions,” pp. 1–11, 2016, doi: 10.1371/journal.pone.0148037.

[21] G. Makransky, “A structural equation modeling investigation of the emotional value of immersive virtual reality in education,” *Educ. Technol. Res. Dev.*, vol. 66, no. 5, pp. 1141–1164, 2018, doi: 10.1007/s11423-018-9581-2.

[22] J. Levitan *et al.*, “International Review of Research in Open and Distributed Learning Contextualizing E-Learning Experiences With Indigenous Communities : A Practical , Research-Based Approach Contextualizing E-Learning Experiences With Indigenous Communities : A Practical , Research-Based Approach,” 2026.

[23] H. Debasu and A. Yitayew, “Examining Elements of Designing and Managing of Creating Inclusive Learning Environment : Systematic Literature Review,” vol. 39, no. 1, pp. 33–43, 2024.