

How Immersive Should Learning Be? Educational VR Immersion Level and Perceived Learning in Schools (Short paper)

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עד כמה למידה צריכה להיות אימרסיבית? רמת האימרסיביות ותפיסת הלמידה במציאות מדומה בבתי ספר (מאמר קצר)

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Abstract

Immersive technologies enable experiential learning by allowing students to engage with digitally simulated environments that support presence, interactivity, and emotional involvement. These systems vary widely in immersion level, from Desktop VR (DVR) displayed on a computer screen, to Immersive Rooms (IR) with 360° classroom projections, to fully immersive VR headsets that envelop learners' senses. Although increasingly used in K–12 contexts, little is known about how different immersion levels influence students' perceived learning given that this effects their motivation and interest to learn in these environments.

This study examined how DVR, IR, and fully immersive VR affect students' perceived immersion and perceived learning, and whether these effects vary by student age and teacher experience. Participants were 252 students aged 9–16 from Israeli schools. Immersion was assessed with items adapted from Selzer and Castro (2022), and perceived learning with the Perceived Learning Questionnaire (Blau & Caspi, 2010). A two-way MANCOVA tested effects of technology and age, controlling for teacher experience.

Findings showed that technology type significantly influenced immersion and all dimensions of perceived learning. DVR consistently yielded the highest perceived immersion and learning, IR the lowest, and fully immersive VR intermediate. Significant Technology × Age interactions indicated stronger benefits of immersive technologies for younger students, with differences declining among older learners.

Overall, the results that moderate-immersion formats, such as DVR, offer an effective balance of engagement, cognitive clarity, and usability. Aligning immersion level with

learners' developmental readiness appears essential for effective immersive learning design.

Keywords: Immersive Learning, Virtual Reality in Education, Perceived Learning, Educational Technology.

Introduction

Immersive technologies offer new opportunities for experiential learning by allowing students to engage with digitally simulated environments that support presence, interactivity, and emotional involvement (Croghan et al., 2025; Makransky & Petersen, 2021). In education, these systems vary widely in immersion level – from Desktop VR (DVR), 3D environments on a computer screen, to Immersive Rooms (IR) that project 360° visuals across classroom walls, and fully immersive VR headsets, which envelop learners' visual and auditory channels (Radianti et al., 2020).

Despite their growing use, little is known about how these technologies shape students' perceived learning - their cognitive, emotional, and social sense of understanding - in K–12 settings. Research shows that children's cognitive and attentional capacities influence their responses to immersive environments (Makransky & Lilleholt, 2018), and that teacher experience affects how such environments are structured and delivered during instruction (Serrano-Ausejo et al., 2024).

Research Aims and Objectives

The current research examined students' self-perceived sense of immersion and perceived learning when engaging with three types of immersive technologies that differ in their level of immersiveness: DVR, IR and VR.

The study addressed the following research question:

How do immersive technologies (DVR, IR and VR) differ in their effects on students' perceived immersion and cognitive, emotional, and social learning, and to what extent are these effects influenced by teacher experience and student age?

Methodology

Participants

The study involved 252 students aged 9–16 from existing classroom groups in Israeli schools. Across all schools, immersive lessons covered multiple subject areas (e.g., science, technology, social studies, foreign languages/ESL, social-emotional learning, geography, and mathematics). Students participated in one of three immersive technology formats: DVR (n = 95), IR (n = 81), or VR (n = 76). Age groups were 9–12 (n = 113), 13–14 (n = 91), and 15–16 (n = 48). Due to school scheduling, no students aged 15–16 participated in the DVR condition. Teacher experience was categorized as 1–2 years (n = 27), 3–5 years (n = 107), and 6+ years (n = 118).

Measures

Immersion was measured using items adapted from Selzer and Castro (2023). Cognitive, emotional, and social learning were assessed using the validated Perceived Learning Questionnaire (Blau &

Caspi, 2010). All items were rated on a six-point Likert scale (1 = strongly disagree, 6 = strongly agree).

Construct Validation

A confirmatory factor analysis (CFA) supported the four-factor structure. One emotional item (QE2) was removed due to low loading. The revised model showed acceptable fit: $\chi^2/df = 1.77$, RMSEA = .056, SRMR = .08, with CFI (.893) and TLI (.866) approaching the .90 threshold. Composite scores were then calculated using the retained items. Reliability was acceptable across all scales ($\alpha = .73-.86$).

Procedure and Analysis

Lessons were delivered in authentic classroom settings, and students completed questionnaires immediately afterward. A two-way MANCOVA examined the effects of technology type and age on perceived learning, controlling for teacher experience. Significant multivariate results were followed by univariate ANCOVAs and Bonferroni-adjusted comparisons. The study received ethical approval from the Israel Ministry of Education Chief Scientist Office and the participating institutions.

Findings and Discussion

Preliminary Analyses

Preliminary analyses examined whether background variables influenced students' learning perceptions. A MANOVA test with age as a fixed factor and teacher experience as a covariate revealed significant multivariate effects for both variables, as well as a significant interaction. Univariate tests showed that age and teacher experience affected all four learning outcomes. Because both contributed meaningfully to variability in students' perceptions, age was retained as a factor and teacher experience as a covariate in subsequent analyses.

Main Analysis: Effects of Immersive Technology

A two-way MANCOVA was conducted to examine the effects of immersive technology type (Desktop VR, Immersive Rooms, fully immersive VR) and student age on perceived immersion, and on cognitive, emotional, and social learning, controlling for teacher experience. The analysis revealed a significant multivariate main effect of technology, indicating that the immersive format meaningfully shaped students' learning perceptions. Significant multivariate effects were also found for age and for the Technology \times Age interaction, demonstrating that technology effects varied across developmental stages.

Follow-up univariate ANCOVAs showed that technology significantly affected all four learning dimensions. The largest effects emerged for immersion and cognitive learning, suggesting that differences between technologies were most pronounced in how present students felt in the environment and how effectively they perceived they learned from it. Estimated marginal means (Table 1) indicated that Desktop VR (DVR) consistently produced the highest scores across all domains, outperforming Immersive Rooms (IR) and, in some cases, fully immersive VR (VR). IR showed the lowest ratings overall, suggesting that this medium-immersion environment may not provide the interactional or cognitive support necessary for strong learning perceptions.

Table 1 presents the estimated marginal means and Bonferroni comparisons for each learning outcome across the three technology types and age groups.

Table 1. *Estimated Marginal Means and Pairwise Comparisons for Main Effects*

Outcome	Technology Type			Post Hoc (Bonferroni)	Student Age Group			Post Hoc (Bonferroni)
	DVR	IR	VR		9-12	13-14	15-16	
	M (SE)	M (SE)	M (SE)		M (SE)	M (SE)	M (SE)	
Immersion	4.17 (.22)	2.72 (.25)	3.99 (.15)	IR<DVR***, IR < VR***	3.47 (.17)	3.82 (.13)	3.29 (.19)	ns
Cognitive	5.20 (.21)	3.23 (.23)	4.03 (.14)	IR&VR < DVR** **, IR < VR**	3.69 (.16)	4.42 (.12)	3.93 (.18)	9-12 < 12-14**
Emotional	5.24 (.23)	4.13 (.26)	4.17 (.16)	IR < DVR*	4.32 (.18)	4.92 (.13)	4.65 (.20)	9-12 < 12-14*
Social	5.30 (.24)	3.74 (.27)	4.55 (.16)	IR < DVR** & VR**	4.23 (.18)	4.84 (.14)	4.12 (.21)	9-12 & 14-16 < 12-14 *

Note: means adjusted for teacher experience (M = 2.36)

Technology × Age Interaction

Table 2 presents the Technology × Age estimated marginal means, illustrating how the effectiveness of each technology varies across developmental groups.

Table 2. *Technology × Age Group Interaction: Estimated Marginal Means*

Outcome	Age Group	DVR	IR	VR
		M (SE)	M (SE)	M (SE)
Immersion	9-12	4.23 (.23)	2.02 (.46)	4.16 (.27)
	12-14	4.10 (.27)	3.31 (.19)	4.04 (.32)
	14-16	- ^a	2.84 (.35)	3.75 (.19)
Cognitive	9-12	5.07 (.21)	1.74 (.43)	4.26 (.25)
	12-14	5.33 (.25)	3.99 (.17)	3.93 (.29)
	14-16	- ^a	3.97 (.33)	3.90 (.17)
Emotional	9-12	5.19 (.24)	2.88 (.48)	4.89 (.28)
	12-14	5.29 (.28)	4.64 (.19)	4.83 (.33)
	14-16	- ^a	4.87 (.37)	4.43 (.19)
Social	9-12	5.25 (.25)	2.58 (.50)	4.85 (.29)
	12-14	5.34 (.30)	4.50 (.20)	4.69 (.34)
	14-16	- ^a	4.13 (.38)	4.11 (.20)

Note. ^a No participants in the DVR/14-16 age group combination; means not estimable for this cell.

Technology effects differed across age groups (Table 2). Among younger students, DVR and VR produced substantially higher immersion and cognitive scores compared with IR. For middle-school students, all three technologies performed more similarly, although IR remained lower overall. Among older students, differences between technologies narrowed further. These patterns suggest that technology-related learning perceptions depend not only on immersion level but also on developmental readiness.

Overall, the findings indicate that DVR offers the most favorable balance of immersion, usability, and instructional clarity, supporting perceived learning more effectively than either immersive rooms or fully immersive VR. Taken together, these patterns suggest that effective use of immersive technologies depends on aligning immersion level with learners' cognitive readiness and classroom interaction needs. Educators should therefore prioritize formats that maintain communication, provide clear guidance, and support sustained engagement.

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