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Article

The Impact of Non-Immersive Virtual Reality on Student Engagement in Higher Education: A Structured Narrative Review (2020-2026)

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Abstract: This structured narrative review examines the role of non-immersive virtual reality (VR) in student engagement in secondary and higher education in the period of 2020-2026. Based on the PRISMA 2020 template, 25 articles were chosen out of 326 records, although the majority of the included studies (21 of 25) were conducted in higher education settings, with secondary education remaining underrepresented. The synthesis of data was conducted in themes and narratively in order to determine trends in terms of emotional, behavioural, and cognitive engagement. The research results have shown that non-immersive VR boosts motivation, enjoyment, and confidence and decreases anxiety, which reinforces emotional involvement. It also enhances engagement with behaviour, encouraging greater participation, collaboration, perseverance and cognitive stimulation by encouraging problem-solving, critical thinking and conceptual knowledge, especially in STEM and engineering education. Although these are the advantages, a number of methodological shortcomings were found, such as inconsistent measures of engagement, limited sample sizes, and limited longitudinal studies, which limit the comparability and the possibility of generalising the results of a long-term impact. These shortcomings underscore the necessity of having more rigorous and standardised research to have a strong evidence base. However, the review finds that non-immersive VR is an affordable, non-sophisticated, and sustainable technology for improving the engagement experience, without the complexity and cost of immersive systems. The following research ought to employ standard engagement systems, integrate qualitative and quantitative methods, and focus on inclusiveness in order to offer equal opportunities. These advantages suggest that non-immersive VR is a promising and scalable technology for digital learning, though stronger empirical evidence is needed to confirm its long-term impact.

Keywords: Non-immersive Virtual Reality; Student Engagement; Educational Technology; Higher Education; Cognitive Engagement; Behavioural Engagement; Emotional Engagement

1. Introduction

VR is among those technologies that have emerged in recent years as one of the most powerful educational technologies to change the face of digital learning, as used by students. Conventionally, VR is a computer-generated, three-dimensional space that recreates real-world or abstract experiences over which learners explore, manipulate, and interact with virtual objects. (Hamilton et al., 2020; Garcia-Ruiz et al., 2025). Although innate attention has been drawn to immersive VR, in which learners experience being fully immersed in a virtual world by means of a head-mounted display (HMD), there has also been an increasing acknowledgement of non-immersive VR, in which learners can engage in virtual worlds on a traditional display, keyboard, or controller. Throughout this review, the term "non-immersive VR" is used as the umbrella term for these screen-mediated systems; the terms "desktop-based" and "screen-based" are used only where a specific study's hardware configuration is being described, and the term "non-fully immersive" is not used elsewhere in this review. These non-immersive systems achieve this by providing interactive 3D learning without having to incur the physical and financial costs that are tied to having immersive hardware. (Spittle et al., 2022; Rao et al., 2024).

Non-immersive VR environments have been used in the educational field to provide simulation of scientific phenomena, engineering processes, medical procedures, and interpersonal communication. (Cabrera-Duffaut et al.,

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2024; Di Lanzo et al., 2020). These applications can be discussed in terms of constructivist and experiential theories of learning, which pay attention to active engagement and problem-solving of knowledge based on exploratory activities and reflection. (Mallek et al., 2024). Non-immersive VR presents flexible, cost-effective, and accessible learning experiences that can stimulate emotional, behavioural, and cognitive engagement of students in comparison to traditional teaching (Alkayed et al., 2023; Bond et al., 2020; Tusher et al., 2024). Nevertheless, the organised knowledge regarding the impact of these dimensions of engagement is yet to be developed in the literature.

Sustained learning is highly involved with emotional engagement, which is usually depicted by motivation, interest, and enjoyment (Bond et al., 2020). Research has found virtual environments to be arousing curiosity and intrinsic motivation through interactive, immersive-like visualisation that does not create a sense of overload of sensory experiences as in full immersion (Spittle et al., 2022; Santilli et al., 2024). As an illustration, it was found that students who were taught in non-immersive VR showed increased enjoyment and reduced anxiety levels in contrast to a traditional learning environment (Qusef et al., 2025; Spittle et al., 2022). On the same note, Jiang and Fryer revealed that the motivation and emotional investment in the learning process by learners in the classroom made by VR-based instruction, despite being screen-based, were significantly higher (Jiang & Fryer, 2023).

The findings highlight that emotional and behavioural engagement in non-immersive VR is inherently linked through emotional drivers such as autonomy, presence, and perceived realism. These emotional drivers translate to observable behavioural differences; VR systems that were gamified or narrative-based produced a positive emotional response in users and more engagement and persistence on tasks. (Irshad et al., 2020; Mallek et al., 2024). The behavioural effect was manifestly stronger in STEM and engineering, where results across social sciences were more equivocal. (Ghanbaripour et al., 2024). Immersive VR may generate stronger sensations; however, non-immersive VR is adequate for achieving motivational outcomes by productively balancing realism and cognitive comfort, which support emotional engagement and persistence in behaviour. (Craig & Kay, 2023; Sunardi et al., 2025).

The engagement behaviour shows observable participation, effort, and time-on-task. VR solutions, which are not immersive, promote engagement by participating in virtual manipulation, exploration, and group simulation (Alzu'bi et al., 2024; Tusher et al., 2024; Zontou et al., 2024). In the aforementioned engineering and design course 2, the students who were using screen-based VR platforms exhibited more persistence and cooperation as compared to those using unchanging instructional materials. (Di Lanzo et al., 2020; Muzata et al., 2024). Similarly, in the study conducted by Cabrera-Duffaut et al., VR-based environments facilitated the acquisition of skills and interaction because they allowed learners to train in digital settings, which were safe and loaded with feedback (Mosleh et al., 2025; Cabrera-Duffaut et al., 2024).

The task interactivity, as well as system usability, also affects the behavioural engagement in non-immersive VR. Lawson et al. and Hedberg et al. highlighted that intuitive interfaces enhance the participation and the desire to experiment in learners (Lawson et al., 2024; Hedberg et al., 2006). On the other hand, too complicated interfaces can lead to less and less interaction as they create brain strain. Non-immersive systems tend to have less technical downtime and increased learning periods when compared with immersive VR and can be used in the classroom over a longer period (Xu et al., 2026; Santilli et al., 2024).

The concept of cognitive engagement is about the mental effort, critical thinking, or problem-solving by the learners in the course of the instruction. Abstract concepts and immediate feedback that can be seen with VR promote profound thinking. (Sherif et al., 2025; Hamilton et al., 2020; Radianti et al., 2020). The studies have shown that VR non-immersive settings provide better conceptual knowledge and support inquiry-driven or experiential learning and exploration. (Muzata et al., 2024; Tsivitanidou et al., 2021). An example is that learners enrolled in non-immersive simulations had better analytical reasoning in engineering problem-solving than those in traditional teaching (Talib et al., 2025; Zontou et al., 2024).

Furthermore, as emphasised by Mallek et al. (2024), virtual learning with an educational theory like social constructivism and experiential learning promotes reflection and metacognition, as two important signs of cognitive engagement. (Mallek et al., 2024). Qiao et al. (2024) and Marougkas et al. (2023) studies also proved the idea that non-immersive VR may be used as a tool to retain and transfer knowledge due to interactive practice and synthesis (Albashayreh et al., 2024; Marougkas et al., 2023; Qiao, et al., 2024).

For consistency throughout this review, the term non-immersive virtual reality (non-immersive VR) is used as the preferred descriptor. This term encompasses desktop-based, screen-based, and other non-fully immersive virtual environments that allow users to interact with simulated content through conventional computer displays rather than head-mounted displays or fully immersive systems. Where alternative terms appear in the cited literature, they are treated as conceptually equivalent to non-immersive VR for this review.

In comparison to immersive VR and standard procedures, non-immersive VR has been proven to have moderately positive results in engagement outcomes when compared in a number of studies on this topic. (George & Titus, 2024; Spittle et al., 2022; Santilli et al., 2024). The effect of non-immersive VR demonstrates a higher potential for sustainability when used in classrooms, primarily because it fatigues the user to a lesser extent and is simpler to facilitate than immersive VR. (Craig & Kay, 2023; Sümer & Vaněček, 2024). Although immersive VR may produce stronger short-term effects, its cost and technical demands often limit practical implementation. Non-immersive VR, by contrast, offers a more practical and scalable option for sustained educational use, trading some sense of presence for greater practicality and lower cognitive load.

Nonetheless, significant methodological limitations remain. Even if many studies use self-reported engagement data rather than objective behavioural data (Lawson et al., 2024; Xu et al., 2026)Small sample sizes and no standardised measurement for engagement influenced the potential for generalising results (Talib et al., 2020; Tene et al., 2024). There also remains a lack of reviews identifying the distinct impact that using non-immersive VR environments has on traditional immersive VR environments, leading to overall conceptual confusion (Zedan et al., 2025; Sunardi et al., 2025). Each of these limitations obstructs any possible intervention that would give educators the necessary evidence base to design meaningful and accessible VR learning experiences. The current systematic review aimed to examine non-immersive VR, to understand the impact non-immersive VR has on student engagement - emotional, behavioural, and cognitive engagement - as educational interventions, at the secondary and post-secondary level. To provide a consistent conceptual framework, this review adopts Fredricks et al.'s (2004) tripartite model of engagement, which conceptualises engagement as comprising emotional, behavioural, and cognitive dimensions. This framework guided the review questions, data extraction, and synthesis.

The review is outlined through the following research questions:

1. What are the emotional changes (e.g., motivation, interest, enjoyment) in the students as a result of non-immersive VR interventions?
2. What behavioural patterns of engagement (i.e., participation, interaction, time-on-task, etc.) are reported about non-immersive VR environments?
3. What is the impact of non-immersive VR procedures on cognitive (e.g., critical thinking, problem-solving, deep processing) engagement?
4. What are the outcomes of engagement using non-immersive VR as compared to immersive VR or standard strategies, and what are some methodological weaknesses?

2. Methodology

2.1 Review Protocol

The structured narrative review was written according to the PRISMA 2020 to ensure methodological transparency and replicability. The objective of the review was to synthesise the evidence on the effect of non-immersive virtual reality (VR) interventions on student engagement at the emotional, behavioural, and cognitive levels in the context of secondary and higher education published in 2020-2026. Though the protocol was never officially registered in PROSPERO or OSF, it was written in their format, and the objectives, eligibility, and steps to be taken were indicated in advance. As the protocol was not prospectively registered, this work is presented as a structured narrative review rather than a fully registered structured narrative review. Reporting consistency was guided by the PRISMA checklist to ensure consistency in reporting procedures of the study. No review protocol was prospectively registered before conducting the study. Consequently, although the review followed the PRISMA 2020 reporting guidelines, the findings should be interpreted in light of the absence of protocol registration. Future reviews should consider prospective registration through platforms such as PROSPERO or the Open Science Framework to enhance transparency and methodological rigor.

2.2 Search Strategy

It was done in the form of a comprehensive search of six multidisciplinary databases: Scopus, Web of Science, IEEE Xplore, ERIC, ScienceDirect, and SpringerLink. The sources selected are related to the research of educational technology and virtual learning. The Boolean search term used below was utilised: (non-immersive virtual reality or desktop VR or screen-based VR) and (student engagement or learning engagement) and (education or classroom). Search filters are used to limit the search results to peer-reviewed journal articles and conference papers in the English language and published between January 2020 and November 2025. A total of 326 records were initially retrieved by the search. To be able to cover as many studies as possible, the reference lists of key research were also screened manually.

2.3 Inclusion and Exclusion Criteria

Inclusion Criteria

In addition to empirical studies, high-quality peer-reviewed review articles were included when they provided synthesized evidence directly relevant to the effects of non-immersive VR on student engagement. These review studies were used to contextualize findings and identify broader trends within the literature but were distinguished from primary empirical evidence during data synthesis.

- Peer-reviewed empirical studies published between 2020 and 2025.
- Focus on education or learning at the secondary or higher education level.
- Test student involvement (emotional, behavioural, or cognitive).
- Use Non-immersive VR technologies (desktop/screen-based system)

Exclusion Criteria

- Research based on fully immersive VR (head-mounted displays, CAVE).
- Simulation medical/clinical rehabilitation or non-educational.
- Films are non-English or non-peer-reviewed.
- Theoretical papers with no empirical information.

These criteria ensured that only those studies that are applicable to general education and non-immersive VR interventions were factored into the studies.

2.4 Study Selection and PRISMA Flow

To enhance the consistency of the screening process, the authors independently reviewed records against the predefined inclusion and exclusion criteria. Any disagreements regarding study eligibility were discussed and resolved through consensus. Where necessary, the full text of the article was re-examined to ensure that inclusion decisions aligned with the review objectives. Although a formal inter-rater reliability statistic (e.g., Cohen's kappa) was not calculated, the use of independent screening and consensus-based resolution procedures helped improve the transparency and reliability of study selection.

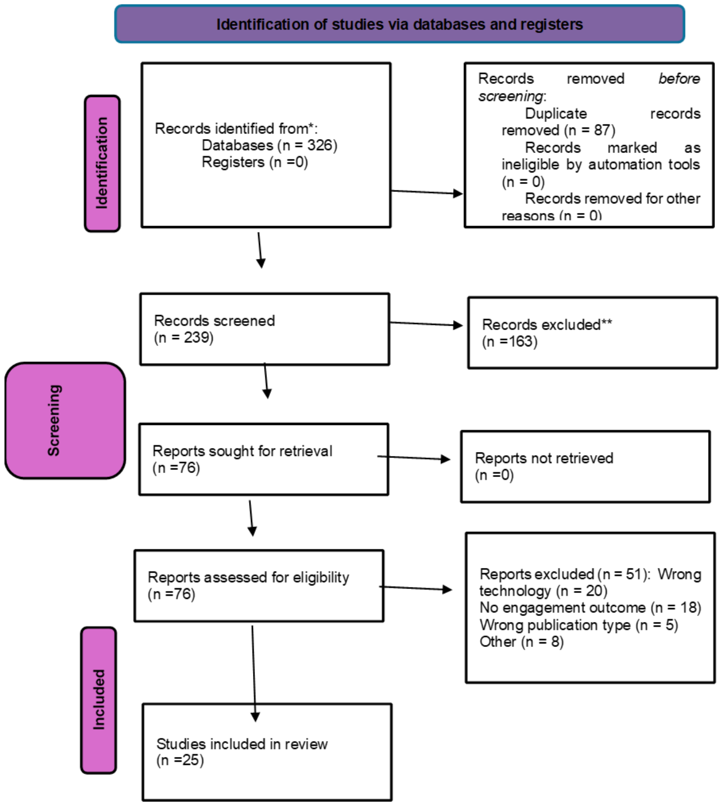

Figure 1: PRISMA FLOW CHART

2.5 Quality Assessment

To determine the quality of the methodology of the selected studies, the Mixed Methods Appraisal Tool (MMAT) was applied. Each of the studies was reviewed by two reviewers based on five criteria: research question clarification, methodological suitability, data collection validity, rigour of data analysis, and whether the data and conclusions agreed. The high level of methodology was revealed in most of the studies. Nevertheless, the most frequent limitations were small-scale samples, absence of control groups, and use of self-reported engagement scales. This fact was supported by multiple strong, structured narrative reviews, which enhanced the credibility of the synthesised results in general.

2.6 Data Extraction

A questionnaire containing a standardised data extraction form was designed to guide standardisation and transparency. Each study was summarised as follows:

- Author(s), Year, and Country
- Education (Secondary or Higher Education) VR Type (Desktop / Non-immersive / Screen-based).
- Subject Area (STEM, Engineering, Nursing, etc.)
- Interest Dimension (Behavioural, Cognitive, Emotional)
- Major Results on Engagement Results.
- Methodological Design (Quantitative, Qualitative, or Mixed-Methods)

Data were independently extracted by two researchers, with each reviewer independently completing the extraction form for every study before comparing entries. Formal inter-rater reliability statistics (e.g., Cohen's kappa) were not computed; instead, discrepancies between reviewers were resolved through structured discussion until full consensus was reached, with a third reviewer available to arbitrate unresolved disagreements. who agreed on the discrepancies by discussing them. The final evidence base consisted of 25 sources, including empirical studies, systematic reviews, scoping reviews, meta-analyses, and conceptual reviews that met the eligibility criteria. The extraction and categorisation of engagement outcomes were guided by Fredricks et al.'s (2004) tripartite model of emotional, behavioural, and cognitive engagement.

2.7 Data Synthesis

Because of the heterogeneity in studies in terms of design, context, and measurement of engagement, thematic and narrative synthesis were used as an alternative to meta-analysis. It was done in three primary phases:

1. Primary Coding: Extraction of Textual information on the results of the engagement was coded into thematic units (motivation, participation, cognitive reflection).

2. Categorisation: The codes were organised into three dimensions of engagement: o Emotional (motivation, enjoyment, interest) o Behavioural (time-on-task, participation, collaboration) o Cognitive (problem-solving/reflection/critical thinking).

3. Interpretation Patterns were seen based on theoretical ideas, including the constructivist theory, self-determination theory, and experiential learning.

Trends (publication years, disciplines, education levels) were also visualised with the help of the descriptive statistics, and frequency counts were determined to show which dimensions of engagement were the most frequently studied.

3. Results

3.1 Overview of Selected Studies

25 sources met the inclusion criteria, comprising both empirical studies and high-quality review articles. The research studies involved the study of how non-immersive virtual reality (VR) improves student engagement in secondary or higher education. Most studies (21 out of 25) were based on the higher education sphere, which is characterised by the strongest results of digital learning innovations since tertiary institutions are the main pilots. Among all the studies, only four actively analysed the secondary-level interventions, indicating that there is low adoption in K-12 settings. The increase in the proportion of the yearly distribution was observed between 2020 and 2024, and the highest levels of publications were reached in 2023 and 2024, which coincided with the increase in the post-pandemic use of digital learning technologies. One of the 25 sources, Mallek et al. (2024), is a conceptual review rather than a peer-reviewed empirical study; it was retained because it provides the theoretical grounding (constructivist and experiential learning theory) used to interpret the empirical findings, and its inclusion is noted as an exception to the empirical-studies inclusion criterion.

Table 1: Overview of Selected Studies (2020–2025)

No.	Author(s) & Year	Country	Education Level	Subject/Discipline	Engagement Focus	Methodology
1	(Spittle et al., 2022)	Not applicable because this is a review article synthesising international research rather than a study	Not education-focused; studies span multiple application domains	Virtual Reality (VR), Immersive Environments, Human–Computer Interaction	Behavioural	Structured Literature Review

		conducted in one country.				
2	(Garcia-Ruiz et al., 2025)	Not specific (review draws on international studies; authors affiliated with Mexico)	Higher Education (primarily Computer Science education)	Various	Cognitive, Behavioural	Structured Literature Review
3	(Rao et al., 2024)	International	Not education -specific	Computer Graphics, Augmented Reality (AR), Virtual Reality (VR)	Primarily technology/design applications	Encyclopedia/ Reference Chapter (Conceptual Overview)
4	(Bond et al., 2020)	Germany	Higher Ed	EdTech	Behavioural, Emotional	Meta-analysis
5	(Mallek et al., 2024)	Canada	Higher Ed	Education Theory	Emotional, Cognitive	Conceptual Review (retained as supporting theoretical evidence, not as a primary empirical study)
6	(Sunardi et al., 2025)	Indonesia	Higher Ed	Education Technology	Behavioural	Scoping Review
7	(Tsivitanidou et al., 2021)	Cyprus	Higher Ed	Physics / Science Education	Cognitive and Emotional Engagement	Quantitative study

8	(Santilli et al., 2024)	Italy	Higher Ed	Comparative Learning	Emotional, Behavioural	Quantitative
9	(Cabrera-Duffaut et al., 2024)	Spain	Higher Ed	Competence Dev.	Cognitive, Behavioural	Qualitative
10	Ghanbaripour et al. (2024)	Australia	Higher Ed	Built Environment	Emotional, Cognitive	Mixed Methods
11	(Craig & Kay, 2023)	Canada	Higher Ed	General	Emotional	Meta-Review
12	(Jiang & Fryer, 2023)	Japan	Higher Ed	Motivation	Emotional	Scoping Review
13	(Hedberg et al., 2006)	United States and Australia	Higher Ed	Educational Technology, Human–Computer Interaction, Instructional Design	Behavioural, Cognitive	Conceptual/Theoretical Chapter
14	(Lawson et al., 2024)	USA	Higher Ed	STEM	Behavioural	Meta-Analysis
15	(Irshad et al., 2020)	Norway	Participants were general VR users	Human–Computer Interaction (HCI), Virtual Reality, Interactive Digital Narratives	Emotional, Cognitive	Conference paper; experimental/prototype-based study
16	(Tusher et al., 2024)	Norway	Higher Ed	Skill Training	Behavioural	Review
17	(Zontou et al., 2024)	Greece	Higher Ed	Engineering	Cognitive, Behavioural	Empirical
18	(Hamilton et al., 2020)	UK	Higher Ed	General	Cognitive, Behavioural	Review
19	(Muzata et al., 2024)	Zambia	Higher Ed	Engineering	Behavioural, Cognitive	Qualitative
20	(Qiao, et al., 2024)	China	Higher Ed	Education	Primarily **Cognitive** (knowledge acquisition, skill development); secondarily Behavioural (clinical skill performance	Meta-analysis

					and practice engagement)	
21	(Marougkas et al., 2023)	Greece	Higher Ed	Pedagogy	Cognitive	Review
22	(Richardson et al.,2023)	United States	Higher Ed	Health Education / Human–Computer Interaction / Medical Simulation	Emotional engagement (empathy development), Behavioural engagement (user engagement and interaction), and User Experience	Quantitative comparative study
23	(Xu et al., 2026)	China	Users of rehabilitation or training technologies	Human–Computer Interaction (HCI), Wearable Technology, Virtual Reality, Rehabilitation Technology	User adoption, user experience, interaction experience, technology acceptance, behavioural intention to use	Quantitative empirical study
24	(George & Titus, 2024)	USA	Higher Ed	Nursing	Emotional	Quantitative
25	(Di Lanzo et al., 2020)	Australia	Higher Ed	Engineering	Cognitive	Review

3.2 VR Technologies and Learning Contexts

The reviewed studies employed diverse non-immersive VR technologies, primarily using desktop-based simulations and 3D interactive platforms accessed via standard monitors or laptops. These systems enable learners to navigate and manipulate virtual objects through mouse, keyboard, or touchscreen interfaces, without the need for head-mounted displays. (Radianti et al., 2020).

Non-immersive virtual reality (VR) technologies in education can be classified into three major categories. The first category represents desktop simulations and 3D virtual labs, and is a specific type of non-immersive VR with many models incorporated in STEM and engineering education. (Di Lanzo et al., 2020; Zontou et al., 2024). This is a way to allow students to capture the virtual experience of replicating experiments in a safe, controlled digital setting and experience phenomena that are complex constructs to visualise without the dangers and costs associated with physical labs, hence enriching conceptual understanding. The second category comprises game-based and gamified learning platforms, which blend non-immersive VR with gamification principles; they promote motivation, engagement, and goal-oriented learning during the learning experience. (Irshad et al., 2020; Mallek et al., 2024). The final category relates to collaborative virtual classrooms and 3D collaborative interactive environments, such as Unity-based or WebGL VR environments, which offer shared digital environments to facilitate interaction, teamwork, and collaborative group learning (Cabrera-Duffaut et al., 2024; Santilli et al., 2024). Generally, non-immersive VR technologies can greatly provide opportunities for students, not only in accessibility and flexibility, but also in support of blended and remote learning contexts compared to fully immersive VR.

3.3 Dimensions of Engagement

To examine how non-immersive VR influences engagement, findings were grouped under the three commonly recognised dimensions: behavioural, emotional, and cognitive engagement.

Table 2. Engagement Dimensions Reported in the Selected Studies

Engagement Type	Description	Representative Studies	Key Observations
Emotional	Motivation, enjoyment, interest, satisfaction	(Spittle et al., 2022); (Jiang & Fryer, 2023); (Santilli et al., 2024); (George & Titus, 2024)	Increased intrinsic motivation, reduced anxiety, and improved enjoyment due to interactivity and autonomy.
Behavioral	Participation, time-on-task, collaboration	(Tusher et al., 2024); (Lawson et al., 2024); (Cabrera-Duffaut et al., 2024);(Hedberg et al., 2006)	Students spent more time engaged in tasks, collaborated more effectively, and demonstrated greater persistence in VR-based activities.
Cognitive	Reflection, problem-solving, critical thinking	(Ghanbaripour et al., 2024); (Zontou et al., 2024)); (Hamilton et al., 2020);(Qiao, et al., 2024)	Improved analytical reasoning, conceptual understanding, and knowledge retention through active exploration.

3.4 Research Methods Used

The findings were synthesised due to the methodological variety across the 25 included studies and triangulated with each other. Eight studies, employing quantitative methods that included surveys and experiments, consistently reported statistically significant improvements in motivation and participation for non-immersive learners using VR. Four studies, which employed interviews and observations, provided additional depth, revealing that students perceived the VR environment as engaging, interactive, and a safe space for learning. These findings were also triangulated with three mixed-methods studies that included a simultaneous measure of engagement as a multi-dimensional construct. Finally, ten structured narrative reviews and scoping reviews contributed to generalising these empirical findings by mapping and synthesising the broader evidence base for the field.

This methodological diversity reflects the level of development in the field, striking a balance between the introduction of new quantitative measurement tools and the continued exploration of the field through qualitative approaches.

3.5 Key Findings

Three cross-cutting themes emerged from the dimension-by-dimension results reported in Section 3.3. Firstly, usability and accessibility were cited as key enablers of engagement at all times. In various studies, the non-immersive VR systems were appreciated due to being able to be used with a regular computer and having limited specialized equipment. This accessibility removed the technical barriers to learning and participation and facilitated prolonged engagement in the classroom and distance settings. It also showed that interfaces that were intuitive and easy to navigate promoted exploration, collaboration, and repeated use, while more complex ones might reduce learner engagement (Lawson et al., 2024; Radianti et al., 2020; Luo et al., 2020).

Second, it seemed that lower cognitive and sensory load helped to maintain engagement. As opposed to the immersive VR systems, non-immersive environments offered interactive experiences without the fatigue, discomfort, or sensory overload that can be experienced in the VR headsets. The results from several studies indicated that this balance between realism and usability facilitated learners' attention for a longer time, which contributed to their motivation, persistence, and cognitive processing (Craig & Kay, 2023; Santilli et al., 2024; Sunardi et al., 2025). The discovery of this may have helped to explain the strong correlation between positive emotional, behavioural, and cognitive outcomes that were often found in the numerous studies that were reviewed.

Third, the evidence base is still limited to particular disciplines and is inconsistent as a result of methodological variability. The majority of studies took place at the secondary and/or higher education level, and mainly on STEM, engineering and technology-related subjects, with less evidence in other subjects. In addition, a variety of self-reported scales, behavioural measures and qualitative assessments were used to evaluate engagement, making comparisons to other studies challenging and findings generalisable (AlDabbas et al., 2025; Bond et al., 2020; Lawson et al., 2024; Sakr & Abdullah, 2024). These inconsistencies indicate the need for a consistent engagement framework and measurement in future studies.

These results, combined, highlight that the value of non-immersive VR could not only be its interactive and immersive nature, but also its utility, accessibility, and ability to provide the opportunity to sustain learner engagement without overloading cognitive or technological capacity.

4. Discussion

This structured narrative review aggregates data from 25 studies published from 2020 to 2025 to explore the impact of non-immersive virtual reality (VR) on the engagement of students in secondary and higher education. Across multiple disciplines, each of the studies consistently illustrates that non-immersive VR increased emotional, behavioural, and cognitive engagement. However, comparing and generalising outcomes from different studies is problematic when studies vary in methodological approaches, theoretical framework, and measurement approaches.

Across the studies reviewed, a consistent pattern emerges around emotional engagement, although the underlying mechanisms differ. Lin et al. (2024) established that VR that involves some level of interactive features or screen-based VR was stimulating learners' curiosity and intrinsic motivation by setting up autonomy for learners to manipulate virtual objects, also without the sensory overload of immersive VR systems. Likewise, Jiang and Fryer (2023) reported that the VR learning environment enhanced students' intrinsic motivation, autonomy, and enjoyment, aligning with self-determination theory (Jiang & Fryer, 2023). Santilli et al. (2024) also noted that students involved in non-immersive simulations were more satisfied than their peers, while also noting that the students experienced less anxiety than students engaged in traditional learning events (Santilli et al., 2024).

Craig and Kay (2023), along with Richardson et al. (2023), pointed out that the emotional engagement afforded by non-immersive VR is sustained when interactivity and cognitive ease are not affected by the fatigue often experienced in immersive VR. (Craig & Kay, 2023; Richardson et al., 2023). Bond et al. (2020) suggested that the feedback loops associated with interaction can further evoke emotional engagement and enjoyment, both of which are essential elements for deeper engagement in one’s learning. (Bond et al., 2020). In specific disciplinary contexts, George and Titus (2024) found that nursing students felt greater emotional safety and confidence in virtual clinical simulations, while Ghanbaripour et al. (2024) found that interactive design elements in built environment education enhanced students' enjoyment and accomplishment. (George & Titus, 2024; Ghanbaripour et al., 2024). Mallek et al. (2024) explained that emotional engagement serves as a precondition to cognitive engagement, as positive emotions help to sustain attention and promote reflective thinking. (Mallek et al., 2024). Together, these studies make explicit the emergent emotional engagement built upon motivation-driven interactivity, feedback, and autonomy to be motivated, thereby engendering positive attitudes about the learning experience.

Across the studies reviewed, behavioural engagement, including participation, persistence, and collaboration, was another key benefit to emerge. Students engaged in desktop-based simulations exhibited more persistence, collaboration, and engagement with tasks when compared to traditional classrooms. (Lawson et al., 2024; Tusher et al., 2024). Similarly, Won et al. (2022) found that non-immersive VR promotes participation and exploratory behaviours, especially in the STEM subjects, where iterative experimentation is an inherent part of the learning experience. (Won et al., 2022). Zontou et al. (2024) noted that 3D non-immersive environments prompted engineering students to spend more time on design tasks and in group coordination when compared to students using standard instructional materials. (Zontou et al., 2024). Muzata et al. (2024) also confirmed that virtual simulations prompted prolonged engagement and collaboration. (Muzata et al., 2024).

Rao et al. (2024) highlighted that usability and accessibility are important factors for primarily technology/design applications (Rao et al., 2024). When students work in non-immersive VR environments, the minimal hardware requirements and reduced likelihood of technical problems contribute to more reliable engagement of students. Usability is also critical in the user experience; Lawson et al. (2024) and Garcia-Ruiz et al. (2025) revealed that students were more inclined to engage in exploration with more intuitively manageable controls, while overly complex controls diminished behavioral engagement. (Lawson et al., 2024; Radianti et al., 2020). Xu et al (2026) illustrated that behavioural engagement could also be observed through digital traces. Students in non-immersive VR engaged more, exhibited more extended engagement on interactive tasks, and demonstrated higher rates of completion. (Xu et al., 2026). Tsivitanidou et al. (2021) identified that behavioural engagement can increase with structured, goal-directed activities in problem-based collaborative learning environments. (Tsivitanidou et al., 2021).

Sunardi et al. (2025) acknowledged that non-immersive VR was practical, affordable, fatigue-free, and integrated into ongoing classroom systems while also supporting behavioural engagement in long-term environments. (Sunardi et al., 2025). Non-immersive VR supports engagement in long-term educational contexts due to the typical repeated use without the physical and financial drains of more immersive VR environments. In conclusion, the existing literature provides evidence of the potential for behavioural engagement through usability, collaboration opportunities, and persistence through task engagement within accessible digital environments in non-immersive VR.

Cognitive engagement, characterised by deep learning, critical thinking, and reflective learning, endorses the most consistent benefit of non-immersive VR. Both Bhatti and Iqbal (2026) and Hamilton et al. (2020) and Radianti et al. (2020) found that virtual simulations offer learners a dynamic visualisation of complex concepts that promote conceptual understanding. (Hamilton et al., 2020; Garcia-Ruiz et al., 2025). Empirical evidence offered by Di Lanzo et al. (2020) and Zontou et al. (2024) in engineering education demonstrates that learners engaging with non-immersive VR demonstrate better problem-solving and spatial reasoning because of real-time feedback and opportunities to experiment multiple times. (Di Lanzo et al., 2020; Zontou et al., 2024).

Mallek et al. (2024) connect these results to constructivist and experiential learning theories, asserting that interactive environments in VR lead learners to construct knowledge through manipulation, reflection, and feedback (Alsetri et al., 2026; Mallek et al., 2024). Similarly, Qiao et al. (2024) noted that non-immersive VR supports metacognition and knowledge retention through opportunities for self-reflection and active learning experience (Qiao et al., 2024). Marougkas et al. (2023) displayed learning tasks organised around problem cycles that support analytic reasoning and synthesis, whereas Ghanbaripour et al. (2024) demonstrated that Built Environment participants developed greater reasoning skills when VR tasks required employing theoretical principles in practical problem-solving challenges (Stiefenhofer et al., 2025; Ghanbaripour et al., 2024; Marougkas et al., 2023).

Lampropoulos and Kinshuk (2024) noted that gamified non-immersive VR applications strengthen cognitive engagement by combining challenge, competition, and real-time feedback, encouraging sustained mental effort. (Irshad et al., 2020). Cabrera-Duffaut et al. (2024) similarly observed that competence development in higher education was enhanced through VR simulations that required analytical decision-making and contextual problem-solving (Cabrera-Duffaut et al., 2024). Luo et al. (2020) added that inquiry-driven learning in non-immersive VR environments fosters hypothesis testing and reflection without the logistical constraints of real laboratories. (Luo et al., 2020). Sunardi et al. (2025) confirmed that non-immersive systems maintain cognitive focus longer than immersive alternatives due to reduced fatigue and greater usability. (Sunardi et al., 2025). Collectively, these studies underscore that cognitive engagement in non-immersive VR results from its capacity to merge interactivity, immediate feedback, and reflective learning within accessible virtual contexts.

When comparing immersive and non-immersive modalities, several studies reveal that non-immersive VR can achieve equivalent engagement outcomes with greater practicality. Craig and Kay (2023) and Santilli et al. (2024) found that while immersive VR enhances presence, non-immersive systems yield comparable emotional and behavioural outcomes without the physical discomfort or cost of immersive setups. (Craig & Kay, 2023; Santilli et al., 2024). Luo et al. (2020) and Garcia-Ruiz et al. (2025) reinforced this, emphasising that non-immersive VR provides scalability and inclusivity for institutions with limited technical resources. (Luo et al., 2020; Radianti et al., 2020).

Nevertheless, there is a lack of a theoretical base amongst the studies in this review. To explain the concept of engagement, for example, while Mallek et al. (2024) and Marougkas et al. (2023) called for applying constructivist and experiential theories, respectively, few studies theoretically grounded themselves in any of those frameworks (Rafi and Bajwa et al., 2026; Mallek et al., 2024; Marougkas et al., 2023). Inadequate theoretical base accounted for Bond et al.'s (2020) and Lin et al.'s (2024) noting that the engagement is multidimensional (emotional, behavioural, and cognitive) and will thus only align with cohesive theoretical models, such as Fredricks et al.'s tripartite model, which provided consistency in conceptualisation (Bond et al., 2020; Lin et al., 2024). Agrees such as Lawson et al. (2024) and Xu et al (2026) noted that the lack of coherence in the theoretical base was, in part, due to measuring engagement with different measures and the small sample sizes across studies (Lawson et al., 2024; Sakr & Abdullah, 2024). In addition, Richardson et al. (2023) suggested that the presence in a non-immersive VR context should be characterised through cognitive immersion rather than sensory immersion, meaning that we should further develop our current understanding of the theory utilised by previous studies to engage with range, beyond withstand and immersive VR (Richardson et al., 2023).

Taken together, these findings suggest that the benefits of non-immersive VR across emotional, behavioural, and cognitive engagement are not independent but mutually reinforcing: lower cognitive and sensory load appears to free up capacity that supports both sustained motivation and deeper processing, while accessible, repeatable interaction supports the persistence that in turn enables cognitive gains. The recurring absence of a shared theoretical lens, however, means that these patterns have largely been described rather than explained.

5. Conclusion

The structured narrative review summarises the findings that non-immersive virtual reality (VR) has a substantial influence on the emotional, behavioural, and cognitive aspects of student engagement improvement. It promotes active participation and encouragement of learning by means of engaging and interesting learning settings. Non-immersive systems offer similar levels of engagement, advantages, and lower costs, are user-friendly, and flexible in different instructional environments compared to immersive VR. Another finding in the review is that the less immersive type of VR remains in its research infancy and is not as prevalent as immersive models. Many of the current studies are short-term, discipline-based, and do not have standardised methods of engagement measurement. Regardless of these constraints, the data indicate that non-immersive VR may become a sustainable and inclusive tool in institutions seeking to enhance their learning experience with minimal financial and technical requirements.Future research should prioritise theoretically grounded investigations using Fredricks et al.'s (2004) engagement framework to improve conceptual consistency and facilitate comparison across studies.

Limitations in the Studies

Though the reviewed studies had positive results, a number of methodological and conceptual shortcomings were observed. To start with, most of the research used small samples, occasionally below 100 individuals, which decreased the representativeness of results and constrained the power of statistical determinations (Lawson et al., 2024; Xu et al, 2026). Second, longitudinal research was lacking, with few studies investigating engagement in the long term, so the sustainability and continuation of the effects of non-immersive VR are barely known (Sunardi et al., 2025). Third, many studies lacked a theoretical basis in this review. The results in terms of VR-based engagement were related to some cited studies of constructivism or experiential learning, yet not as much as the VR-based engagement research connected their results to the existing literature that facilitated the conceptual consistency of the literature review (Mallek et al., 2024). Fourth, even a lack of standardised measures of engagement was expected. The measure of engagement was irregularly defined, and several different tools were used (self-report motivation scale, log behavioural data) to conduct cross-study comparisons (Bond et al., 2020; Spittle et al., 2022). Fifth, the comparison between VR modalities was also inadequate since a few studies directly compared immersive and non-immersive VR, and thus, there is very little knowledge on the effects of different degrees of engagement (Craig and Kay, 2023; Santilli et al., 2024). Lastly, the variability in technology in platforms, software, and hardware arrangement also made interpretation difficult, as was the replication of findings (Garcia-Ruiz et al., 2025). Finally, the evidence base is heavily skewed towards higher education: only 4 of the 25 included studies examined secondary-level interventions, so although the review's objectives and title reference secondary education, the findings and conclusions primarily reflect higher education contexts and should be generalised to secondary settings with caution. A further methodological limitation is that formal inter-rater reliability statistics were not calculated during the screening and data extraction phases. Although disagreements were resolved through discussion and consensus, future reviews should report reliability indices such as Cohen's kappa to enhance methodological transparency and reproducibility. The review protocol was not prospectively registered, which may limit transparency regarding methodological decisions made during the review process.

Future Recommendations

The research should target future studies using longitudinal and large-scale approaches to determine the long-term effects of non-immersive VR on student engagement and learning performance. There is an obvious necessity for standardised measurement instruments to define and measure engagement in a consistent manner across emotional, behavioural, and cognitive levels. Comparative research on immersive and non-immersive VR is suggested to gain a clearer understanding of the pedagogical and psychological differences between varying degrees of immersion. Accessibility, inclusivity, and equity are also issues that researchers should consider, as every learner needs to be able to use VR-based education regardless of their technological and socioeconomic circumstances. Following those directions, tomorrow's research studies can build their evidence base and inform the successful and equitable application of non-immersive VR to contemporary educational practice.

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