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Virtual Reality or Videoconferencing for Online Learning? Evidence from Comparative Meta-Analyses

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 22 May 2025 and was last updated on 22 May 2025.

INTRODUCTION

Review question / Objective This systematic review and meta-analysis aims to evaluate the effectiveness of virtual reality (VR) and video conferencing (VC) platforms in enhancing online learning outcomes. Specifically, the review addresses the following questions: (1) What is the overall effect of VR and VC platforms on online learning performance? (2) How do research context, technological features, and instructional design moderate the learning outcomes associated with these platforms? The review will focus on experimental and quasi-experimental studies involving learners in online learning environments, where VR or VC is the primary intervention, compared either to each other or to traditional online learning tools. The primary outcomes include measures of learning performance, engagement, and satisfaction. Eligible study designs include randomized controlled trials, quasi-experimental studies, and pre-post intervention designs.

Condition being studied The condition being studied is the effectiveness of immersive and interactive technologies, specifically virtual reality (VR) and video conferencing (VC) platforms, in supporting online learning. With the rapid growth of online education, there is an increasing interest in identifying which technological tools can best enhance learning outcomes, engagement, and learner satisfaction. VR offers immersive, simulation-based environments, while VC enables synchronous, socially interactive learning. However, their comparative effectiveness, as well as the influence of contextual, instructional, and technological moderators, remains unclear. This review aims to address this gap by synthesizing evidence from experimental studies evaluating the impact of these platforms on online learning.

METHODS

Search strategy This paper searched journal articles related to online learning through VR and VC platforms. To ensure comprehensive coverage,

two prominent academic databases, Web of Science and Scopus, were consulted. The keywords used to search for literature on VR were "virtual reality" or "metaverse" or "virtual world" and "online learning" or "online teaching" or "online course" or "distance learning." The literature search for VC platforms included the terms "video conferencing" or "Zoom" or "Tencent meeting" and "online learning" or "online teaching" or "online course" or "distance learning." Only studies published between 2003 and 2023 were considered. Initially, a total of 2,321 articles were identified for potential inclusion.

Participant or population The participants included in this review are students engaged in K–12 or higher education institutions who participated in online learning supported by either virtual reality (VR) or video conferencing (VC) platforms. There are no restrictions on gender, geographic location, or other demographic variables. The studies must involve online learning contexts where VR or VC is the primary instructional technology, and the primary outcome measured is related to learning performance.

Intervention The interventions examined in this review include the use of virtual reality (VR) and video conferencing (VC) platforms to facilitate online learning. VR interventions involve immersive or semi-immersive virtual learning environments delivered through technologies such as head-mounted displays (HMDs), desktop-based systems, or mobile VR glasses. VC interventions refer to synchronous, real-time communication tools used for instruction, such as Zoom, Tencent Meeting, and Gather, which allow for live video, audio, and interaction between instructors and learners.

Comparator The comparators in this review include traditional or alternative forms of online learning without the use of virtual reality (VR) or video conferencing (VC) platforms. For VR-related studies, the comparator conditions may include standard online learning methods such as video lectures, text-based instruction, or slide presentations. For VC-related studies, the comparators may involve asynchronous online instruction, discussion boards, or other non-synchronous learning tools. Studies in which both the intervention and comparator groups used VR or VC platforms were excluded.

Study designs to be included This review will include experimental and quasi-experimental study designs that evaluate the effectiveness of virtual reality (VR) or video conferencing (VC) platforms in online learning environments. Specifically, randomized controlled trials, quasi-experimental studies, and pre-post intervention studies with control groups will be considered for inclusion.

Eligibility criteria Articles meeting the following criteria were included in the study. The inclusion criteria were

1. The publication year was limited to the period between 2003 and 2023. The reason for choosing 2003 as the starting year for the literature search is that it marked the launch of Second Life, an innovative three-dimensional virtual world that has had a profound impact on the evolution of VR;
2. Only English-language articles published in peer-reviewed academic journals were eligible for inclusion;
3. Studies that used either a randomized controlled trial (RCT) or quasi-experimental design were considered;
4. The subjects of the studies were students in K–12 or higher education;
5. The studies compared online learning facilitated by VR with those conducted under non-VR conditions. We also made the identical provision for the articles about VC platforms;
6. The dependent variables measured were related to learning effects.

The exclusion criteria were

1. Both the experimental and control groups used VR or VC platforms;
2. The research employed augmented reality, mixed reality, or other technological approaches besides VR;
3. The studies did not provide sufficient data, such as sample size and mean values, necessary to calculate the effect size.

Information sources To ensure comprehensive coverage, two prominent academic databases, Web of Science and Scopus, were consulted.

Main outcome(s) Changes in students' knowledge, skills, and attitudes achieved after completing specific instructional activities are called learning outcomes.

Quality assessment / Risk of bias analysis Publication bias was assessed through the use of a funnel plot and classic fail-safe N test.

Strategy of data synthesis The study effect size analyzed in this study was based on the effect size standard proposed by Cohen. An effect size of 0.2–0.5 was considered small, 0.5–0.8 medium, and 0.8 or greater large. After obtaining all the effect sizes, we chose to use the random-effects model (REM) to calculate the total effect size, as

suggested by Borenstein, et al., because we could not guarantee that the true effect sizes of all studies were exactly the same, which made the fixed-effects model implausible.

Subgroup analysis Subgroup analyses will be performed to examine the moderating effects of: (1) research context (sample size, discipline, grade level), (2) technological features (VR equipment type, VC camera option, platform), and (3) instructional design (pedagogy, outcome type). Between-group heterogeneity will be used to test subgroup differences.

Sensitivity analysis Sensitivity analyses will be planned to assess the robustness of the meta-analytic findings. If substantial heterogeneity or outliers are identified, a leave-one-out analysis will be conducted to examine whether any single study has a disproportionate impact on the pooled effect size. Additionally, analyses may be repeated excluding studies assessed to be at high risk of bias.

Language restriction English.

Country(ies) involved China.

Keywords virtual reality; videoconferencing platforms; online learning; learning outcomes; meta-analysis.

Contributions of each author

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