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INPLASY

Technology-Enhanced Sex Education: A Systematic Review and Meta-Analysis (2000–2024)

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ADMINISTRATIVE INFORMATION

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Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 7 October 2025 and was last updated on 7 October 2025.

INTRODUCTION

Review question / Objective This systematic review aims to evaluate the effectiveness of technology-based sex education for adolescents and young adults worldwide. Following the PICOS framework, the Population includes adolescents and young adults in both formal and informal educational settings; the Intervention comprises digital tools such as websites, applications, social media, games, virtual reality, and generative AI; the Comparison involves traditional face-to-face instruction or no intervention; the Outcomes focus on changes in sexual health knowledge, attitudes, and behaviors; and the Study design includes empirical studies published from 2000 to 2024 using experimental, quasi-experimental, or mixed-method approaches. The objective is to synthesize global evidence on technology-enhanced sex education, identify how technological and pedagogical features influence learning outcomes, and determine the overall effectiveness and moderating factors of technology-based interventions.

Condition being studied The condition being studied is the persistent challenge of inadequate sexual and reproductive health among adolescents and young adults. Globally, this population remains highly vulnerable to sexually transmitted infections (STIs), including HIV, unintended pregnancies, and sexual violence, all of which pose serious physical, psychological, and social consequences. Despite international efforts to promote comprehensive sexuality education (CSE), many regions—especially low- and middle-income or culturally conservative societies—still experience limited access to effective, age-appropriate sex education. Traditional classroom-based instruction often faces barriers such as cultural taboos, insufficient teacher training, and limited interactivity, leading to superficial knowledge transmission and poor behavioral outcomes. In this context, technology-enabled sex education has emerged as a promising approach to overcoming these limitations. By utilizing digital tools such as apps, games, websites, social media, and virtual reality, technology can provide private, engaging, and interactive learning environments that enhance

knowledge acquisition, attitude change, and behavioral competence. This study therefore focuses on addressing the global public health condition of adolescent sexual health risks through the systematic evaluation of technology-facilitated interventions in sex education.

METHODS

Search strategy The literature search was conducted systematically across major academic databases, including Web of Science Core Collection (SCI, SSCI, AHCI, and ESCI) and PubMed, to ensure comprehensive coverage of peer-reviewed empirical studies. The search was limited to English-language publications between January 1, 2000, and December 31, 2024. The following search terms and Boolean operators were applied:

Search string:
("sex education" OR "sexual health") AND ("technology" OR "technological" OR "digital media" OR "virtual reality" OR "game" OR "mobile application" OR "artificial intelligence").

Additional filtering and manual screening were performed to remove duplicates and exclude review articles, conceptual papers, and non-empirical studies. Eligible studies were required to (1) focus on sex education as the primary topic, (2) use technology as the main intervention or delivery method, and (3) report measurable outcomes related to knowledge, attitudes, or behaviors. Reference lists of relevant papers were also examined through snowballing to identify additional eligible studies.

Participant or population The participants included in this review are adolescents and young adults who have engaged in technology-facilitated sex education programs across various educational and cultural contexts. This population typically includes individuals aged 10 to 24 years, encompassing middle school, high school, and university students, as well as out-of-school youth participating in informal learning environments. Studies involving mixed-gender groups are most common, although some focus exclusively on female or male participants. Participants may come from diverse geographic regions, including high-income, middle-income, and low-income countries, reflecting a broad range of sociocultural, educational, and technological conditions. All included studies must examine the impact of digital or technology-based interventions—such as websites, mobile apps, social media, games, virtual reality, or artificial intelligence—on participants' sexual health knowledge, attitudes, and behaviors.

Intervention The interventions evaluated in this review are technology-based or technology-facilitated sex education programs designed to improve adolescents' and young adults' sexual health knowledge, attitudes, and behaviors. These interventions employ a variety of digital tools and platforms, including websites, applications, social media , games, videos, virtual reality , and generative artificial intelligence systems. The programs typically integrate interactive and multimedia features—such as quizzes, simulations, feedback systems, and gamified learning modules —to promote engagement and active learning. Some interventions are implemented within formal educational settings (e.g., schools and universities), while others are delivered in informal or community-based contexts, enabling access for out-of-school youth. Depending on the design, interventions may include computer-based scaffolding, teacher-guided facilitation, or blended approaches that combine digital learning with face-to-face support. Overall, these interventions aim to enhance participants' understanding of sexual and reproductive health, foster positive attitudes, and encourage safe and responsible sexual behaviors.

Comparator The comparator in this review includes studies that evaluate traditional or non-technological approaches to sex education or those involving no intervention. Traditional interventions typically consist of face-to-face, classroom-based instruction led by teachers or health educators, often relying on lectures, printed materials, or discussion-based activities without the use of digital tools. In some studies, the comparison group receives standard curriculum-based sex education, while the experimental group participates in a technology-enhanced program. Other studies may employ control groups with no exposure to sex education interventions during the study period. These comparators provide a basis for assessing the added value and effectiveness of technology-based approaches in improving sexual health knowledge, shaping attitudes, and promoting positive behavioral outcomes among adolescents and young adults.

Study designs to be included This review will include empirical studies that provide quantitative or qualitative evidence on the effectiveness of technology-based sex education. Eligible study designs encompass experimental studies (including randomized controlled trials and quasi-experimental designs), pretest–posttest studies,

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cross-sectional surveys, mixed-methods research, and qualitative studies that examine participants' experiences, perceptions, or implementation processes. Only peer-reviewed journal articles published between 2000 and 2024 in English will be included. Studies must explicitly evaluate the impact of.

Eligibility criteria Additional eligibility criteria were established to ensure the rigor and relevance of the included studies. Inclusion criteria were as follows: (1) studies published in peer-reviewed journals between January 2000 and December 2024; (2) studies written in English; (3) studies focusing primarily on sex education or sexual health promotion; (4) interventions that use technology as the main mode of delivery or facilitation; and (5) studies reporting measurable educational outcomes such as changes in knowledge, attitudes, or behaviors.

Exclusion criteria included: (1) duplicate publications; (2) studies not available in full text; (3) non-empirical works, including reviews, conceptual papers, commentaries, editorials, and theoretical discussions; (4) studies where technology was not a central component of the intervention (e.g., minor use of media for dissemination); (5) interventions not directly related to sex education (e.g., general health or relationship education); and (6) non–peer-reviewed sources, such as dissertations, reports, and conference proceedings. These criteria ensure that only high-quality, empirical, and directly relevant evidence is synthesized in the review.

Information sources The information sources for this review will include multiple electronic databases and supplementary search methods to ensure comprehensive coverage of relevant literature. Primary databases to be searched are the Web of Science Core Collection (including SCI, SSCI, AHCI, and ESCI) and PubMed, as these provide extensive access to peer-reviewed studies in health, education, and social sciences. The search will be limited to English-language publications from January 2000 to December 2024.

In addition to database searches, manual reference screening (snowballing) will be conducted using the bibliographies of relevant systematic reviews and included articles to identify additional eligible studies. Grey literature, dissertations, and unpublished reports will not be included to maintain the methodological quality and peer-review standard of the included studies.

Main outcome(s) The main outcomes of this review focus on evaluating the effectiveness of technology-based sex education interventions among adolescents and young adults. Primary outcomes include measurable changes in sexual health knowledge, attitudes, and behaviors following participation in digital or technology-facilitated programs. These outcomes will be assessed through quantitative indicators such as mean differences, standardized effect sizes (Hedges' g or Cohen's d), and confidence intervals, comparing intervention and control groups or pretest–posttest results.

Data management All retrieved records and reference data will be managed using EndNote reference management software. After database searches are completed, all citations will be imported into EndNote for centralized storage, organization, and screening. The software will be used to automatically identify and remove duplicate records prior to the eligibility screening process. Titles and abstracts will then be screened within EndNote according to predefined inclusion and exclusion criteria, followed by full-text review of eligible studies.

Data extraction will also be managed through EndNote, with key study information (e.g., author, year, population, intervention type, outcomes, and effect measures) organized into customized reference fields and exported to Microsoft Excel for coding and meta-analysis. This process ensures a transparent, traceable, and systematic workflow for managing bibliographic data, maintaining version control, and supporting the reproducibility of the review.

Strategy of data synthesis Data synthesis will be conducted through a combination of quantitative meta-analysis and qualitative synthesis to comprehensively evaluate the effectiveness of technology-based sex education. For quantitative data, statistical analyses will be performed using Comprehensive Meta-Analysis (CMA) version 3.0 software. Effect sizes will be calculated using Hedges' g, which adjusts for small-sample bias, and corresponding 95% confidence intervals will be reported. A random-effects model will be applied to account for variability across studies. Statistical heterogeneity will be assessed using the Q statistic and I^2 index, with thresholds of 20%, 50%, and 80% representing low, moderate, and high heterogeneity, respectively.

Subgroup and moderator analyses (e.g., by grade level, intervention type, pedagogy, scaffolding, and assessment design) will be conducted to identify factors influencing intervention effectiveness. Publication bias will be examined using funnel plots and fail-safe N tests. For studies lacking sufficient quantitative data, findings will be synthesized narratively, summarizing key patterns

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in intervention design, implementation context, and outcomes. Both quantitative and qualitative results will be integrated in the discussion to provide a comprehensive understanding of how technology enhances the delivery and impact of sex education.

Subgroup analysis Subgroup analyses will be conducted to explore potential moderators that may influence the effectiveness of technology-based sex education interventions. Based on the conceptual framework and data availability, the following subgroups will be examined:
Grade level – comparing effects among middle school, high school, and university students to identify age-related differences in learning outcomes.
Educational setting – contrasting interventions implemented in formal classroom environments versus informal or community-based settings.
Type of technology – analyzing differential effects of games, apps, websites, videos, social media, virtual reality, and generative AI on sexual health outcomes.
Pedagogical approach – comparing direct instruction, question-and-answer, game-based, experiential, collaborative, and case-based learning methods.
Scaffolding design – assessing the impact of computer-based, teacher-guided, and blended scaffolding on learning effectiveness.
Assessment method – examining whether technology-based, traditional, or mixed assessment approaches influence learning outcomes.
Each subgroup analysis will be performed using a random-effects model, and differences between subgroups will be tested using between-group Q statistics (Qb). These analyses aim to identify contextual and instructional factors that moderate the overall effectiveness of technology-facilitated sex education.

Sensitivity analysis A sensitivity analysis will be conducted to evaluate the robustness and stability of the meta-analytic results. This process will involve systematically reanalyzing the data by excluding individual studies one at a time (leave-one-out method) to determine whether any single study disproportionately influences the overall effect size. In addition, analyses will be repeated after excluding studies with a high risk of bias or low methodological quality based on the quality assessment results.
Where possible, comparisons will also be made between fixed-effect and random-effects models to assess the consistency of results across different statistical assumptions. Furthermore, sensitivity tests will be performed by excluding studies with extreme effect sizes, small sample sizes, or insufficient reporting of key data (e.g., missing standard deviations). The stability of pooled estimates across these conditions will indicate the reliability of the main findings. Results of the sensitivity analysis will be reported narratively and visually, highlighting whether conclusions remain consistent after adjustments.

Language restriction English.

Country(ies) involved China.

Keywords sex education; digital technology; adolescents; systematic review; meta-analysis.

Contributions of each author
Author 1 - Xinyu Fan - Author 1 is responsible for leading the development of this review, including determining the review topic, screening articles, conducting coding, and drafting the manuscript.
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