Interdisciplinary Journal of Virtual Learning in Medical Sciences

Protocol

The Effectiveness of Immersive Educational Technologies Compared to Non-Immersive Ones on Clinical Skills among Nursing and Midwifery Students: A Protocol for a Systematic Review

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ABSTRACT

Background: Learning clinical skills is one of the most crucial responsibilities of medical students, particularly for midwives and nurses. Nowadays, teaching clinical skills and simultaneously moving towards online training, such as using Immersive Educational Technologies (IETs), presents a challenge that midwives and nurses face. The primary objective of this study is to determine whether IETs, compared to Non-Immersive ones, is effective in clinical skills among nursing and midwifery students.

Methods: This protocol has been created in accordance with the recommendation from the Cochrane Collaboration. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P) checklist has been used in planning this protocol. The health professions, including nursing and midwifery students, are the target populations of this study. We will include randomized clinical trials or controlled trials that investigate the effectiveness of IETs on clinical skills among nursing and midwifery students. Traditional clinical education learning methods, including face-to-face (didactic) learning, classroom learning, in-person clinical instruction, in-person clinical attachments, multimedia, games, and e-books, among others, are comparators. The primary outcome of this study is to measure clinical skill performance among nursing and midwifery students and compare the efficacy of IETs and non-immersive ones. Clinical skills should be measured objectively through clinical examination or a reliable and valid checklist for assessing clinical skills or clinical competence. Randomized clinical trials or controlled trials will be eligible for inclusion in the review.

Conclusion: Given the increasing growth of IETs, the findings of this study can be utilized by healthcare decision-makers to prioritize educational approaches based on their efficacy and efficiency, particularly during times of crisis.

Note: A preprint of this study has been published at https://www.researchsquare.com/article/rs-2422073/v1.

Keywords: Clinical Competence; Education; Distance; Nursing; Students

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Please cite this paper as:
Zarifsanaiey N, Barahmand N, Mehrabi M, Safarpour AR. The Effectiveness of Immersive Educational Technologies Compared to Non-Immersive Ones on Clinical Skills among Nursing and Midwifery Students: A Protocol for a Systematic Review. Interdiscip J Virtual Learn Med Sci. 2025;16(2):120-127.doi:10.30476/ijvlms.2025.105419.1326.

Received: 07-01-2025
Revised: 12-05-2025
Accepted: 12-05-2025

Introduction

One of the most essential strategies for preparing students to enter the clinical environment, accept responsibility, and enhance their ability to make health decisions is clinical education (1). Studies have shown that medical students, especially midwives and nurses, who are on the front line of treatment, face some difficulties in learning clinical skills to achieve a level of competence and safe performance in clinical environments (2-5). In recent years, the COVID-19 pandemic has presented a challenge in teaching clinical skills to medical students, as it increases the risk of disease transmission (6). At this time, due to the closure of educational environments and the implementation of social distancing measures, there was a shift towards online training; however, concerns arose about whether clinical skills could be effectively taught online (7). There is evidence that students can learn clinical skills through online resources. However, the effectiveness of this learning is unknown. However, the use of these technologies in teaching clinical skills continues (8). Educational technologies have transformed the way we learn. Technologies such as virtual reality, augmented reality, and mixed reality, known collectively as immersive technologies, are software based on effective educational methods. These educational technologies are rooted in constructivism and experiential learning. They create an environment where learners engage in activities, enhancing their creativity and gaining a deeper understanding of concepts (9). Immersive Educational Technologies (IETs) compared to Non-Immersive Educational Technologies (NIETs) create the feeling of being in a three-dimensional environment compared to conventional two-dimensional environments (10, 11).

The Cochrane databases (CDSR), Scopus, PROSPERO, and PubMed were searched to identify past systematic reviews and ongoing protocols. A systematic review conducted in 2022 by Ryan and colleagues found that immersive technology did not alter the knowledge gained by medical and nursing students compared to conventional methods but did enrich their learning experience (9). Additionally, a systematic review protocol by McNamara and colleagues was identified in the Prospero system, which examined the use of immersive technology in teaching clinical skills in medical education and how these abilities have been assessed and their effectiveness quantified (12). Another systematic review, published in 2021 by Bartit and colleagues, found that the use of these immersive, salient, motivating, and engaging technologies was effective in most cases; however, few studies reported no difference in effectiveness (13).

The current study aims to explore whether there is a distinction between immersive and non-immersive educational methods regarding the change (increase or decrease) in the clinical skills of nurses and midwives during the pandemic. Additionally, it seeks to determine whether variations in factors such as sex and age have influenced these changes. To date, no comprehensive study has been conducted to date that can answer our research question. This study will assess the global impact of using immersive technologies compared to other technology-based methods on the clinical skills of nurses and midwives. As technologies continue to improve, it is essential to evaluate their effectiveness in various areas regularly.

Objectives

Primary Objective

To determine whether IETs, compared to NIETs, are effective in clinical skills among nursing and midwifery students.

Secondary Objectives

• To compare two methods of education, taking into account the effect of age groups, gender, study semester, the field of study (nursing, midwifery), level of education (bachelor's, master's, doctorate), and employment at the same time.

• To compare two training methods considering the effect of the type of clinical skills presented.

• To compare two teaching methods considering the influence of the geographical area.

• To compare two methods of education considering the impact of the university level.

Review Question

The systematic review study has been guided by the following research question: "What has been the impact of IET compared to NIET on clinical skills among nursing and midwifery students?"

PICOT

Population: Health professions including nursing and midwifery students.

Intervention: We will include randomized clinical trials or controlled trials that investigate the effectiveness of immersive educational technologies on clinical skills among nursing and midwifery students.

Comparisons: Traditional clinical education learning methods, face to face (didactic) learning, classroom learning, in-person clinical instruction, in-person clinical attachments, multimedia, games, e-books and so on.

Outcome: The primary outcome of this study is measuring clinical skill performance among nursing and midwifery students, comparing the efficacy of IETs and NIETs. Clinical skills, which include essential competencies such as patient assessment, procedural techniques, and clinical decision-making, are critical for effective healthcare delivery. These skills should be measured objectively using clinical examinations or reliable, validated checklists to assess clinical skills or competence.

Type of studies: Randomized clinical trials or controlled trials will be eligible for inclusion in the review.

Condition or Domain Being Studied

The focus of this systematic review is clinical education.

IETs are included - Clinical and educational technologies, such as virtual reality, augmented reality, and mixed reality — collectively referred to as immersive technologies — are software designed based on effective educational methods. These technologies are designed based on the theories of constructivism and experiential learning, creating an environment where learners engage in activities and their creativity increases, leading to a deeper understanding of the concepts (9).

NIETs are included - Other clinical educational tools classified as non-immersive include traditional clinical education learning methods, face-to-face (didactic) learning, classroom learning, in-person clinical instruction, in-person clinical attachments, multimedia, games, e-books, and similar methods.

Methods

Study Design and Setting

This protocol was developed based on recommendations from the Cochrane Collaboration (14). The Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P) checklist has been used in planning this protocol, which is available in the supplementary file (15). This review will include all settings including hospitals, private clinics, health centers, and university settings. This study will impose no restrictions based on age, gender, academic department or group, university affiliation, geographic location, race, time, or cultural background in the use of this technology.

Eligibility Criteria

Types of Participants

Studies in which nurses, midwives, and nursing and midwifery students participated in all bachelor, master and doctoral degrees will be included in the present study. Studies that included a combination of medical group participants, including nurses or midwives, will not include in the study.

Types of Interventions

We will include randomized clinical trials or controlled trials that investigate the effectiveness of IETs on clinical skills among nursing and midwifery students.

Types of Comparators

IETs could be compared to all types of NIETs including multimedia, games, e-books and so on.

Main Outcomes

The primary outcome of this study is measuring clinical skill performance among nursing and midwifery students. Clinical skills should be measured objectively through clinical examination or a reliable and validated checklist for assessing clinical skills or clinical competence. Clinical skills education, especially for midwives and nurses, as frontline professions in patient care, is one of the essential strategies for preparing students to enter the clinical environment, accept responsibility, and enhance their ability to make informed health decisions. Examining the effectiveness of new educational methods in teaching clinical skills and comparing these methods with traditional ones can be an important step in adopting more effective methods. The results will lead to improved clinical decision-making and treatment methods in patients' care.

Measures of Effect

The measures of effect for continuous outcomes will include mean differences and standardized mean differences.

Additional Outcomes

• To compare two methods of education, taking into account the effect of age groups, gender, study semester, the field of study (nursing, midwifery), level of education (bachelor's, master's, doctorate), and employment at the same time.

• To compare two training methods considering the effect of the type of clinical skills presented.

• To compare two teaching methods considering the influence of the geographical area.

• To compare two methods of education considering the impact of the university level.

Outcome Assessment Tools

All standardized, validated, and reliable "clinical skills rating scales" suitable for nurses and midwiferies will be included in our review.

Exclusion Criteria

We will exclude the following study types: Observational studies (i.e. cross-sectional studies, cohort studies), case reports, comments, letters to the editor, daily reports, books, summaries without full text and animal studies. We will use narrative reviews, systematic reviews, and meta-analyses to check the references for our review.

Search Strategy and Sources

In order to conduct the most comprehensive search, all available sources including published and unpublished studies will be reviewed. Related databases such as Scopus, PubMed, Clarivate Analytics, ASSIA, CINAHL, EMBASE, Education Research, Medline, BEI, BNI and Eric, Google Scholar search engine, intervention registration systems such as 'All Trials' and 'RIAT', and grey literature will be reviewed between 1950/01/01 and 2022/12/31. Furthermore, there will be no language restriction for including studies. The full syntax of the PubMed database is shown in Table 1. To produce this syntax, keywords from MeSH, Emtree and ERIC thesaurus banks have been utilized. Components are Immersive Educational Technologies (AR, VR, MR and simulation) AND nurses and midwives.

Procedure for screening and study selection

We will collect all retrieved studies in EndNote software from all databases, removing duplicate records. After a primary search, two independent reviewers will initially screen titles and abstracts to identify eligible studies based on the inclusion and exclusion criteria. After eliminating ineligible studies, the full texts of the remaining studies will be reviewed to ensure eligibility. Discrepancies between the reviewers will be resolved by discussion and consultation with a fourth reviewer.

Table 1: Search syntax for PubMed database from 1950/01/01 to 2022/12/31

Number	Search Terms	Number
1	((Technology AND Educational) OR "Educational Technologies" OR (Technologies AND Educational) OR "Instructional Technology" OR (Technology AND Instructional) OR "Instructional Technologies" OR (Technologies AND Instructional) OR "Augmented Realities" OR (Realities AND Augmented) OR (Reality AND Augmented) OR "Mixed Reality" OR "Mixed Realities" OR (Realities AND Mixed) OR (Reality AND Mixed) OR (Reality AND Virtual) OR ("Virtual Reality" AND Educational) OR "Educational Virtual Realities" OR "Educational Virtual Reality" OR (Reality AND "Educational Virtual") OR ("Virtual Realities" AND Educational) OR ("Virtual Reality" AND Instructional) OR "Instructional Virtual Realities" OR "Instructional Virtual Reality" OR (Realities AND "Instructional Virtual" OR (Reality AND "Instructional Virtual") OR ("Virtual Realities" AND Instructional) OR Exergamings OR "Active-Video Gaming" OR "Active Video Gaming" OR "Active-Video Gamings" OR (Gaming AND Active-Video) OR (Gamings AND Active-Video) OR "Virtual Reality Exercise" OR (Exercise AND "Virtual Reality") OR (Exercises AND "Virtual Reality") OR "Virtual Reality Exercises" OR Exergames OR Exergame OR simulate OR "simulation model" OR "simulative modeling" OR "simulative modelling" OR "computer simulation")	1,067,737
2	(Nurse OR (Personnel AND Nursing) OR "Nursing Personnel" OR "Registered Nurses" OR (Nurse AND Registered) OR (Nurses AND Registered) OR "Registered Nurse" OR Nurse-Midwives OR Nurse-Midwife OR "Nurse Midwife" OR "Pupil Nurses" OR (Student AND Nursing) OR (Nurses AND Pupil) OR (Nurse AND Pupil) OR "Pupil Nurse" OR "Nursing Student" OR "Nursing Students")	527,384
3	1 AND 2	20,995
4	1950/01/01:2022/12/31[dp]	
5	3 AND 4	7,078

NNR (Number Needed to Read): 11

Data Collection

The data extraction table will be developed according to the recommendations from PRISMA and will be refined after the pilot testing of four studies. Data will be extracted from the full text of the articles. Two reviewers, independently, will be extracted data from all included studies. Discussions and consultations with a third reviewer will resolve discrepancies between the two reviewers.

The following information will be extracted from each study: first author's name, year of publication, study country and location, design of the study, participants' characteristics, study duration, sample size, study's quality, type of comparison arm, measurement tools for evaluation of outcome(s) of the studies, and Mean (SD) and Standard Error (SE) of scores in both groups in the studies.

In cases where eligible studies provide incomplete statistical information, we will compute the missing data or contact the study authors via email. The article will be excluded if the study authors do not respond to queries for three times.

Risk of Bias Assessment

The risk of bias assessment of the included studies will be performed using the Cochrane Collaboration tool by two independent reviewers (14). Any discrepancies between reviewers will be resolved through consensus or the opinion of a third expert. The Cochrane tool considers random sequence generation, allocation concealment, insufficient outcome data, blinding of personnel and participants,

blinding of outcome assessors, selective outcome reporting, and other sources of biases. Finally, the overall risk of bias for each study will be judged as 'high', 'low,' or 'unclear'.

Data Analysis

Pooled Analysis

If the methodological heterogeneity among all the final included studies is not substantial, the pooled standardized mean difference will be computed. The combination method will be based on methodological similarities among the included studies, using either the Fixed Effect Model or the Random Effect Model. Forest plots will be created for all studies to display the separate and pooled effect sizes, along with their corresponding 95% confidence intervals. Stata V.14.1 (StataCorp, USA) will be used for the statistical analysis in the current study. If the methodological heterogeneity of the included studies is considerable, we will not combine them, and a narrative qualitative report will be prepared.

Assessment of Heterogeneity

Statistical heterogeneity of the results will be evaluated by the I^2 statistic, Q-statistic test, and the corresponding 95% confidence intervals. The I^2 statistic of 0%–40%, 30%–60%, 50%–90%, and 75%–100% will be judged as 'perhaps not important', 'moderate heterogeneity', 'substantial heterogeneity', and 'considerable heterogeneity', respectively. $P<0.05$ will be considered significant for the Q-statistic test (14).

Subgroup Analysis

For assessing the sources of statistical heterogeneity, subgroup analysis according to the age and gender of the participants, academic semester, field of study (nursing, midwifery), level of education (bachelor's, master's, doctorate), concurrent employment at the same time, geographical region (continents), and type of clinical skills will be performed.

Sensitivity Analysis

A sensitivity analysis will be conducted to evaluate methodological quality, study design limitations, data analysis considerations, and the impact of missing data. This analysis will employ the one-out remove method, in which one paper will be excluded at a time, and pooled effects of other studies will be calculated and compared.

Quality Analysis

The relationship between the methodological quality of the eligible studies and their outcomes will also be analyzed. If notable differences are observed between the results of high-quality and low-quality studies, only those articles meeting a predefined minimum standard of methodological quality should be used to provide a reliable summary estimate of the combined outcomes from these eligible studies.

Assessment of Publication Biases

Publication bias arises when the probability of a study being published depends on the nature or direction of its results, which can result in 'small-study effects,' where smaller studies tend to report more favorable outcomes for the intervention. To assess publication bias, we will first visually examine the funnel plot for asymmetry. Furthermore, a statistical approach using Egger's test will be used to test the symmetry of the funnel plot. A non-significant result from Egger's test indicates that the funnel plot is symmetrical, suggesting the absence of publication bias.

Confidence in Cumulative Evidence

We will use the Grading of Recommendation, Assessment, Development and Evaluation tool (GRADE) to assess the certainty of the evidence.

Discussion

This systematic review and meta-analysis study will show the effectiveness of IETs compared to NIETs. The use of IETs will demonstrate their appropriateness for nurses and midwives students. Given the increasing growth of immersive educational technologies, the findings of this study can

be utilized by healthcare decision-makers to prioritize educational approaches based on their efficacy and efficiency, particularly during times of crisis.

This systematic review protocol is comprehensive; however, it does have certain limitations. Its specific focus on nursing and midwifery students may limit its applicability to other healthcare disciplines. By only including randomized and controlled trials, it may overlook insightful qualitative or observational studies that provide a deeper understanding of the impact of educational technology. Differences in how clinical skills are measured and the types of interventions used might create inconsistencies, making it hard to compare results. Using grey literature could raise questions about reliability.

Abbreviations

IETs: Immersive Educational Technologies
NIETs: Non-Immersive Educational Technologies

Acknowledgements

This article originated from a research project (decree code: IR.SUMS.REC.1399.363) conducted at Shiraz University of Medical Sciences (SUMS), Shiraz, Iran. We express our gratitude to the research counselor at SUMS for their invaluable support throughout this study, as well as to the Clinical Research Development Centre of SUMS for their assistance with analysis.

Authors' Contribution

The study's conception and design were carried out by NZ, NB, MM, and ARS. Drafting and revising the manuscript involved the same group of authors. The development of the syntax was performed by MM and ARS, who also conducted the search process. All authors have reviewed and approved the final version of the manuscript.

Conflict of Interest

The authors declare that they have no competing interests. Nahid Zarifsanaiey and Manoosh Mehrabi, as members of the Editorial Board, were not involved at any stage in managing this manuscript. The Editorial Board has brought together independent experts to assess this paper without their awareness.

Ethical Considerations

In light of the nature of the research, no ethical issues were identified that necessitated further consideration.

Funding/Support

Not applicable.

Availability of Data and Materials

The study has been registered in the PROSPERO database with the Registration Number CRD 42022369713, available at https://www.crd.york.ac.uk/PROSPERO/view/CRD42022369713. The checklist used in planning this protocol is available in the supplementary file.

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