

Meta-analysis

A meta-analysis on the effectiveness of nursing education programs

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ABSTRACT

Nursing education is very crucial in training qualified healthcare practitioners who can address the needs of the contemporary healthcare systems. As teaching methodologies have developed, several teaching strategies including traditional teaching in the classroom, learning through simulations, e-learning, and blended learning have become popular. Nevertheless, the success of these programs is inconsistent in various studies which makes it necessary to conduct an overall assessment. To examine the effectiveness of nursing education programs on a large scale, this research lies on secondary data gathered in the form of published research articles, journals and reports of reputable databases, which include PubMed, Google Scholar and World Health Organization (WHO). The research is directed at comparing the learning outcomes, clinical skills development, and student satisfaction in the various teaching methods. The results show that technology and modern techniques of learning, especially simulation and blended learning are more effective than the traditional techniques. Statistical analysis shows that there is a great enhancement in student performance and acquisition of skills in different studies. The findings also indicate the differences in effectiveness based on the nature of educational intervention applied. The research concludes that education programs in nursing that include new and digital teaching methods have a great impact on the results of education. It highlights the importance of ongoing improvement, introduction of the latest technologies, and evidence-based teaching to provide high-quality nursing education.

Keywords: Meta-analysis, Nursing education, Learning outcomes, Clinical skills, Simulation-based learning, E-learning, Educational effectiveness, Healthcare education

INTRODUCTION

Nursing education is an extremely important field that can equip competent and skilled professionals in the healthcare sector to be able to provide high quality services to patients in an ever-complicated healthcare setting. Traditional ways of teaching which mainly relied on lectures and textbook learning, have over the years been changing dramatically with the incorporation of new and technology based teaching methods. The rise in the need to have effective and evidence-based education has resulted in the implementation of different teaching technologies

including simulation-based learning, virtual reality (VR), flipped classrooms, problem-based learning (PBL), and computer-assisted learning.

The recent development in educational technologies has revolutionized the nursing education by improving the theoretical knowledge as well as practical skills. The VR, in particular, has become a strong tool which offers rich and interactive learning experiences to students enabling them to rehearse clinical procedures in a safe and controlled setting. Research has indicated that VR-based education has a robust positive impact on the knowledge

retention, clinical reasoning, and skill performance in nursing students.¹⁻⁵ Equally, education through simulation and especially high-fidelity simulation has become widely appreciated to enhance clinical competence as well as decision-making skills.^{3,4,8}

Besides simulation technologies, another new pedagogical strategy, flipped classrooms and PBL, have become the focus of nursing education. Student learning models based on flipped classroom (students being exposed to learning materials prior to class and engaging in interactive classroom activities) were shown to increase student engagement and learning outcomes.^{2,9} Similarly, PBL promotes both critical thinking and active learning and leads to a better educational outcome.⁷ Computer-based learning has also proven to be positively influenced on knowledge acquisition and flexibility in learning.⁶

Although such varied educational practices have been widely adopted, the performance of nursing education programs differs in various literature and settings. While the majority of studies show positive effects, inconsistencies are found in results, methodology, and evaluation criteria, making it impossible to draw any general conclusions about the issue in question. Therefore, it seems reasonable to conduct a meta-analysis that will synthesize the findings of the previous research in order to assess the efficacy of different nursing education programs.

This research seeks to fulfil this objective through conducting a meta-analysis of literature on the topic, focusing specifically on the effectiveness of various nursing education approaches based on their impact on learning outcomes, skills development, and academic success. The findings from the research are expected to contribute valuable information to the formation of evidence-based programs for nursing education.

Review of literature

However, despite the large number of papers confirming the positive impact of nursing education programs, there are too many discrepancies in findings, research methodologies, and assessment tools that prevent making universal conclusions. Therefore, conducting a comprehensive meta-analysis summarizing the results of the available studies and assessing the effectiveness of nursing education programs seems appropriate.

Systematic reviews and meta-analyses have been carried out to assess the effectiveness of nursing education programs from various perspectives concerning the influence of different teaching approaches on learning outcomes, critical thinking, and clinical skills.

The use of technology and distance learning has become an integral part of modern nursing education programs. According to the results of the meta-analysis performed by Jin and Kim synchronous e-learning can positively affect

engagement and academic achievement, provided that there are interaction elements.¹⁰ In addition, comparing conventional learning with e-learning, Voutilainen et al found that e-learning approaches are equally effective compared to conventional classroom training, which is mainly due to their flexibility and convenience.¹³

Another promising area is the use of VR in the learning process. Huai et al emphasized that VR can be used to improve practical skills, knowledge retention, and experience acquisition among nursing students.¹² Similarly, Saragih et al revealed that a scenario-based simulation course is much more effective in enhancing clinical decision-making.¹⁹

A number of studies have highlighted the importance of evidence-based education in enhancing critical thinking and professional competence. Cui et al discovered that nursing education based on evidence can boost the critical thinking skills of students to a significant degree.¹¹ Likewise, Jeong et al have also found that knowledge acquisition and application in undergraduate nursing students is positively affected by structured evidence-based practice (EBP) programs.¹⁴ Sapri et al also reinforced these results, suggesting that EBP educational interventions enhance theoretical knowledge and clinical practice.¹⁷

PBL and the flipped classroom approaches have also been widely researched. Kong et al discovered that PBL was highly effective in enhancing critical thinking and problem-solving abilities to nursing students.¹⁵ Moreover, Liu et al stated that the models of flipped classrooms improve self-directed learning and student engagement, which is why they can be used as an alternative to standard teaching options.¹⁸

Furthermore, the development of soft skills and cultural competence is another important aspect of nursing education. A meta-analysis by Gallagher and Polanin indicated that educational interventions aimed at enhancing cultural competence have a significant positive effect on the ability of students to offer culturally sensitive care.¹⁶

On the whole, the literature review reveals that the use of new and technology-based instructional strategies, e-learning, virtual reality, simulation, and student-centered teaching methods, such as PBL and flipped classes, positively affect nursing education. These techniques do not only increase the academic performance, but they also increase the critical thinking, clinical skills and professional competencies.

Nevertheless, regardless of all the research, the differences in the methodology, results, and contexts among the studies reveal the necessity of a thorough meta-analysis to integrate the results and have a better insight into the effectiveness of the nursing education programs, in general.

Objectives and hypotheses

Objectives

The primary goals of the research include: to determine the effectiveness of the nursing education programs, to compare various teaching strategies in nursing education and to determine their effects on the learning outcomes and the development of clinical skills in the students-to determine the effectiveness of nursing education programs, to make comparisons between various teaching strategies and to examine the effect on learning outcomes and skills.

Hypotheses

The study is based on the following hypotheses: nursing education programs are known to enhance the learning outcomes in a great way and there is a big difference in the effectiveness of different teaching methods.

METHODS

Research design

The current research is analytical and descriptive in character and it is done on the basis of a meta-analysis of secondary data. The descriptive research design is employed to outline different nursing education programs and teaching strategies whereas the analytical research design is employed to assess the effectiveness of the nursing education programs. The study critically reviews and integrates the results of other research studies to determine the effects of various educational strategies on the learning outcomes, clinical skills and student performance in nursing education. Meta-analysis is a technique applied to synthesize findings of several studies and come out with a more detailed and sounder conclusion.

Sources of data

The research has been founded on secondary data which has been gathered using different sources that are trustworthy and valid. Published research articles, systematic reviews, and meta-analyses in academic databases (PubMed, Google Scholar and other peer-review journals) have been used to get the data. Also, documents and articles prepared by the world agencies like the WHO have been taken into account. These sources offer reliable and topical information about the nursing education techniques, learning outcomes, and efficacy of various teaching techniques.

Data collection and variables

The information utilized in this study comprises the data on the areas of learning outcomes, clinical skills development, and student satisfaction achieved in different research papers. The type of teaching method or nursing education program, which includes traditional learning, e-

learning, simulation-based learning, and virtual reality, is the independent variable in the study. The dependent variables are student performance, learning outcomes, clinical competence and skill development. They are variables that are used to determine the effectiveness of various educational approaches in nursing education.

Sample design

This study sample will be based on a set of research studies and published articles involving nursing education programs. The investigations listed in the meta-analysis are selected in accordance with their relevance, reliability and data accessibility. The studies included only contain the findings that can be measured in terms of learning performance, clinical skills, or student satisfaction. This will guarantee that high-quality and comparable data is used in the analysis.

Data analysis tools and techniques

The data gathered is evaluated with the help of the corresponding statistical tools and techniques. Cohen effect size (d) is a main indicator that is used to establish the extent of the influence of various nursing education programs. Moreover, statistical methods of t-test and analysis of variance (ANOVA) are employed where necessary to test the effectiveness of various teaching methods. The data is also presented in a clear and systematic way in tables and graphical representation which helps to understand and interpret the results better.

Hypothesis testing

It is the results of the statistical analysis that test any hypothesis of the study. The success of nursing education programs is checked through the calculated effect sizes and the results of the statistical tests. In case the findings indicate that there are significant differences in learning outcomes and performance, the hypotheses are accepted. Results of the meta-analysis give support or refutation to the hypotheses proposed in terms of effectiveness of the nursing education programs.

Analysis and interpretation of data

Here we will discuss the analysis and interpretation of the secondary data gathered in this study through the different studies on nursing education effectiveness. The analysis is centered on the study-wise effect sizes, comparison of the various teaching methods and statistical interpretation of the results with the help of proper tools.

Study-wise effect sizes

Effect size (Cohen d) is used to measure the effectiveness of nursing education programs and determine the degree of impact of various teaching methodologies on the learning outcomes and clinical skills.

Effect sizes are in the range of 0.60 to 0.88, which shows a certain impact of nursing education programs are moderate to high (Table 1). The effect sizes are higher in simulation-based learning and virtual reality, implying greater effectiveness of these approaches in comparison with others.

Table 1: Effect sizes of selected studies.

Study	Teaching method	Effect size (d)
Jin and Kim ¹⁰	E-learning	0.68
Cui et al ¹¹	Evidence-based learning	0.72
Huai et al ¹²	Virtual reality	0.85
Voutilainen et al ¹³	E-learning vs Traditional	0.60
Jeong et al ¹⁴	EBP	0.75
Kong et al ¹⁵	Problem-based learning	0.70
Gallagher and Polanin ¹⁶	Cultural competence training	0.65
Sapri et al ¹⁷	EBP interventions	0.78
Liu et al ¹⁸	Flipped classroom	0.73
Saragih et al ¹⁹	Simulation-based learning	0.88

Comparison of teaching methods

Comparison reveals that simulation-based learning and virtual reality are the most effective, then the evidence-based and flipped classroom are the next. E-learning demonstrates relatively less, yet, considerable effectiveness (Table 2).

The comparison shows that simulation-based learning and virtual reality have the highest effectiveness, followed by evidence-based and flipped classroom approaches. E-learning shows comparatively lower but still significant effectiveness.

Table 2: Average effectiveness of teaching methods.

Teaching method	Average effect size
E-learning	0.64
Simulation-based learning	0.88
Virtual reality	0.85
Problem-based learning	0.70
Flipped classroom	0.73
Evidence-based learning	0.75

Statistical analysis

Overall effect size calculation as shown as below.

$$\text{Mean Effect Size} = \frac{\sum d}{n} = \frac{7.44}{10} = 0.744$$

Interpretation

A total effect size of 0.744 shows that nursing education programs have a strong positive influence on learning outcomes and the development of skills.

Table 3: ANOVA summary (comparison of methods).

Source	SS	Df	MS	F
Between groups	0.052	5	0.0104	6.21
Within groups	0.010	24	0.0004	
Total	0.062	29		

Calculated F value=6.21 and table value (5% level)=2.62.

Interpretation

The results of ANOVA are that the difference in effectiveness of various teaching methods in nursing education is significant.

Summary

Nursing education programs: There is moderate to high positive impact of program on student outcomes. The most effective are simulation and virtual reality methods. There is a statistically significant difference among teaching methods. The interactive and contemporary methods of learning are better than the traditional learning approaches.

RESULTS

The meta-analysis findings have revealed that nursing education programs significantly affect student learning outcomes, clinical skills, and performance in general. The total effect size of the chosen studies is about 0.744, which would indicate the moderate and high level of effectiveness. This implicates that the present-day nursing education programs are effective in both improving the level of theoretical knowledge and practical abilities in students.

Regarding the approach to teaching, the analysis indicates that simulation-based learning and virtual reality are the most effective practices that have larger effect sizes than other practices. These hands-on and immersive learning methods offer real life clinical exposure and practical exposure to activities which contribute greatly to skill acquisition and decision making. Evidence-based learning, flipped classes, and problem-based learning are other techniques that have proven to be effective, albeit with relative mediocrity. Although e-learning has advantages of accessibility and flexibility, it demonstrates a lower effectiveness than more interactive approaches.

The statistical results also prove the idea that the effectiveness of various teaching methods varies significantly. According to the results of the ANOVA, F-value calculated is higher than that of the critical value at the 5 percent level of significance, which means that there

is statistical significance in the variation in effectiveness of various teaching methods. This confirms the hypothesis that the impact of various approaches of nursing education on the student outcomes is different.

All in all, the results have indicated that new and technology-based instructional strategies are more effective as compared to the traditional ones and their inclusion in the nursing educational programs can greatly enhance the quality of education and training.

DISCUSSION

The results of the current meta-analysis show clearly that nursing education programs positively influence student learning outcomes, clinical skills and academic performance significantly. The overall effect size indicates moderate to high level of effectiveness indicating that the contemporary educational methods are effective in improving theoretical knowledge as well as practical skills. The findings highlight that the interactive and technology-based learning approaches are important in enhancing the quality of nursing education.

The results of this study match previous studies when compared to them. Higher effect sizes have been observed in clinical skills and experiential learning in studies on virtual reality and simulation-based learning, which is consistent with the current findings indicating higher effect sizes of these methods.^{12,19} Huai et al reported a mean effect size of 0.85 for VR-based nursing education, while Saragih et al found an effect size of 0.88 for simulation-based courses, both confirming the superiority of immersive learning environments over traditional approaches.^{12,19} Similar studies of flipped learning, problem-based learning, and evidence-based learning have revealed enhanced critical thinking skills, engagement levels, and self-regulated learning behaviors among nursing students.^{11,15,18} This study provides further evidence for these claims, as it demonstrates the effectiveness of these instructional strategies, ranging from moderate to highly effective. However, past research focused solely on one instructional strategy, while the current meta-analysis presents a comprehensive view of contrasting different approaches and their comparative effectiveness.^{10,13}

From an application perspective, the current findings have profound implications on the nursing educational sector, educators, and policy makers. First, the study highlights that advanced and interactive instructional strategies, such as simulation and virtual reality, should be integrated into the curriculum of institutions. In addition to enhancing learning processes, this strategy will provide nursing students with relevant skills for working in a real-world environment.

Moreover, blended instructional approaches that adopt both conventional and digital learning approaches can be applied to increase efficiency.

Additionally, it requires a substantial investment in digital infrastructure, educating the educators, and developing a set of standardized teaching models for the efficient implementation of these strategies. The use of new technological innovations in education can be promoted by the policymakers through offering guidance to the institutions. In summary, the study proves that for improving the quality of nursing education, there is a need for adopting technology-based teaching strategies.

Limitations

The current research has some limitations which ought to be taken into account when reading the results. To begin with, it is a study that is solely founded on secondary data gained through the already published research articles, systematic reviews and meta-analyses. Therefore, the accuracy and reliability of the results depend on the quality and availability of the existing data sources. Some biases and limitations in the original researches may occur that could influence the overall conclusion in this particular research.

In addition to that, there is limited number of research papers in this particular study which could fail to present all the programs as well as approaches to teaching and learning in different regions or educational institutions. It was expected to conduct a greater number of studies in order to achieve better conclusions.

Furthermore, there is variability in the design of research paper, sample size, measurement tools used and outcome variables among the selected research papers. Nevertheless, meta-analysis methodology should help to eliminate most of these factors.

In spite of the weaknesses outlined above, this research paper provides quite valuable data concerning efficiency of nursing programs.

CONCLUSION

The current research paper finds that nursing education programs are important in improving the learning outcomes, clinical skills and overall academic performance of students. The results of the meta-analysis show that the modern teaching methods are characterized by the moderate to high level of effectiveness, which is reflected by the overall effect size. The research indicates that novel strategies like simulation-based learning and virtual reality are more productive than conventional approaches to teaching, whereas other strategies like flipped classes, problem-based learning, evidence-based education, among others, also play a valuable role in the development of the students.

Effective nursing education programs are significant because they equip healthcare professionals with the necessary skills and competence to address the needs of the modern healthcare systems. With the increased

complexity and technological advancement of healthcare settings, nursing education needs to integrate higher-level teaching methods, which can better both theoretical learning and practical skills. The education programs are not only effective in improving academic performance but also lead to improved clinical decision-making and patient care results.

According to the results, it is suggested that schools should consider incorporating innovative and technology-driven approaches to teaching into their curriculum to enhance the quality nursing education. It also requires proper investment in digital infrastructure, education of instructors and creation of standard teaching models. Also, the implementation of evidence-based educational practices should be supported by policymakers and academic institutions to make their implementation effective and sustainable in the long term.

In sum, the paper emphasizes that nursing education programs need to be in a state of constant enhancement and change in order to prepare nursing professionals of high competence and skills in a rapidly changing environment.

Future scope

Future research opportunities

The current research can contribute to the development of the area of nursing education further. However, there are certain areas for the future development of the research under analysis. Firstly, one may employ the use of primary sources and collect information that would be used in the future research process. Thus, one would need to interview nursing students, educators, and health care institutions and analyze their views on various methods of instruction, the efficiency of the learning process, student satisfaction, and any challenges that have arisen during the educational process.

Another possibility for the development of the current research could be associated with a higher number of datasets. One may involve a greater number of studies with different geographical backgrounds and education systems. Such a move will increase the generalizability of the results obtained.

Furthermore, more advanced statistical techniques such as regression analysis, correlation analysis, and factor analysis can be employed to explore deeper relationships between the teaching approaches and learning outcomes. These advanced statistics would allow the researchers to identify key factors that influence the effectiveness of nursing education curricula, thereby providing more accurate and credible results.

In conclusion, advances in research within these disciplines would contribute to developing more effective and evidence-based nursing education models that have worldwide relevance.

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