

IMPACT OF ARTIFICIAL INTELLIGENCE ON STUDENT LEARNING OUTCOMES IN HEALTHCARE EDUCATION: A CROSS-SECTIONAL STUDY

¹Zakir Hussain Parray ² Ravinder Singh ³ Kirandeep Kaur ⁴ Mr. Mohd Shafi Sheikh ⁵ Ms. Preethi.P

¹Master Trainer ²Assistant Professor AIMS Bathinda. ³Assistant Professor Khalsa College. ⁴Assistant Professor School of Life and Health Sciences Joy University. ⁵Assistant professor in Anaesthesia technology Apollo University

¹Anaesthesia & Operation Theatre Technology

¹Emviversity, Bangalore, India

Abstract: Artificial intelligence (AI)-based tools are increasingly being introduced into healthcare education, yet evidence on how they influence learning outcomes among allied health students remains limited in the Indian context. This cross-sectional study examined the association between exposure to AI-assisted learning tools (adaptive practice modules, AI-driven feedback and virtual case simulation) and learning outcomes among 188 students enrolled in allied health and paramedical training programmes. Students exposed to AI-assisted resources over one academic semester were compared with peers taught through conventional methods on theoretical knowledge, practical skill proficiency and self-reported clinical confidence. The AI-assisted group recorded consistently higher mean scores across all three domains, with the largest gain observed in clinical confidence. The findings suggest that structured integration of AI-based tools can meaningfully strengthen learning outcomes in healthcare education, though the cross-sectional design limits causal inference and calls for confirmation through longitudinal and interventional research.

Index Terms - Artificial intelligence, healthcare education, learning outcomes, medical education, allied health students, cross-sectional study.

I. Introduction

Artificial intelligence has moved rapidly from a peripheral curiosity to a routine feature of health professions training. Adaptive learning platforms, AI-generated case scenarios, chat-based tutoring systems and automated feedback engines are now used alongside traditional lectures and bedside teaching in medical, nursing, and allied health curricula [1], [2]. Proponents argue that these tools can personalise the pace and content of instruction, provide instant feedback that is otherwise difficult to deliver at scale, and allow repeated, low-stakes practice of clinical reasoning and procedural skills [3].

Despite this enthusiasm, the empirical picture of how AI-based instruction actually affects measurable student learning outcomes is still developing. Recent systematic reviews report a growing but heterogeneous body of evidence: several single-centre studies point to gains in knowledge acquisition and skills performance, while others find effects limited to specific domains such as communication or diagnostic reasoning, with performance still short of expert human benchmarks in some tasks [4], [5]. Much of this evidence originates from high-resource settings and a narrow set of professional programmes, leaving a gap in understanding how AI-assisted learning performs among allied health and paramedical students training in resource-constrained clinical education environments such as those common in India.

Need of the Study

Allied health training programmes, including operation theatre technology, medical laboratory technology and nursing diploma courses, depend heavily on repeated procedural practice, timely feedback and consistent

access to updated theoretical content. Faculty-to-student ratios in many institutions constrain how much individualised feedback each learner can realistically receive. If AI-assisted tools can supplement this feedback loop without compromising the quality of learning, they could meaningfully improve training capacity in precisely the settings that need it most. However, before such tools are adopted at scale, programme administrators require locally grounded evidence on whether their use is actually associated with improved outcomes, and in which domains the benefit is largest. This study was undertaken to address that evidence gap.

II. Literature Review

Comparative studies of AI-assisted instruction against conventional teaching in health professions education have generally reported favourable, if uneven, effects on academic performance. A systematic review of interventional studies published between 1986 and 2023 found that AI-based educational interventions were associated with improvements in skills acquisition, attributed partly to the ability of AI tools to provide a repeatable, low-pressure practice environment that removes the constraints of time and place inherent to traditional clinical teaching [6]. A separate synthesis covering studies through October 2024 similarly reported measurable gains from AI-based tools and virtual-patient simulations, while noting that most available studies were small, single-centre trials, and that AI-driven communication training still lagged behind human-led instruction in some respects [4].

Reviews focused specifically on generative AI tools describe support for personalised, self-directed learning as a consistent theme, alongside concerns about the comparatively limited evidence base for collaborative or group-based use of these tools [7]. A recent systematic review and meta-analysis of randomised controlled trials in undergraduate health professions education, spanning medicine, pharmacy, nursing and allied health, was undertaken specifically to quantify these effects across classroom, skills-based and clinical teaching contexts [5]. Taken together, this literature supports the plausibility of a positive association between AI-assisted learning and student outcomes, while underscoring the need for further studies, including in contexts and professional groups that remain under-represented, such as allied health training in South Asia [8].

III. Research Methodology

This section outlines the study design, population and sample, data collection procedure, variables and the statistical approach used to analyse the data.

3.1 Study Design and Population

A cross-sectional comparative design was used. The study population comprised students enrolled in allied health and paramedical diploma/degree programmes (including Operation Theatre Technology and Medical Laboratory Technology) at participating training institutes. Students who had completed at least one semester of clinical training were eligible for inclusion.

3.2 Sample and Data Collection

A total of 188 students participated: 95 students who had substantial exposure to AI-assisted learning resources (adaptive question banks, AI-generated case simulations and automated feedback tools) during the semester, and 93 students taught predominantly through conventional lecture- and demonstration-based methods, serving as a comparison group. Data were collected using a structured, pre-validated assessment covering theoretical knowledge (multiple-choice items mapped to the course curriculum), a practical skills checklist scored by blinded evaluators during a standardised procedural task, and a self-reported clinical confidence scale. All data were collected within a single assessment cycle, consistent with the cross-sectional design.

3.3 Study Variables

The independent variable was the extent of exposure to AI-assisted learning tools (AI-assisted vs traditional group). The dependent variable was student learning outcome, operationalised across three domains: theoretical knowledge score, practical skill proficiency score and self-reported clinical confidence score, each expressed as a percentage of the maximum attainable score. The conceptual framework guiding the analysis is presented in Figure 1.

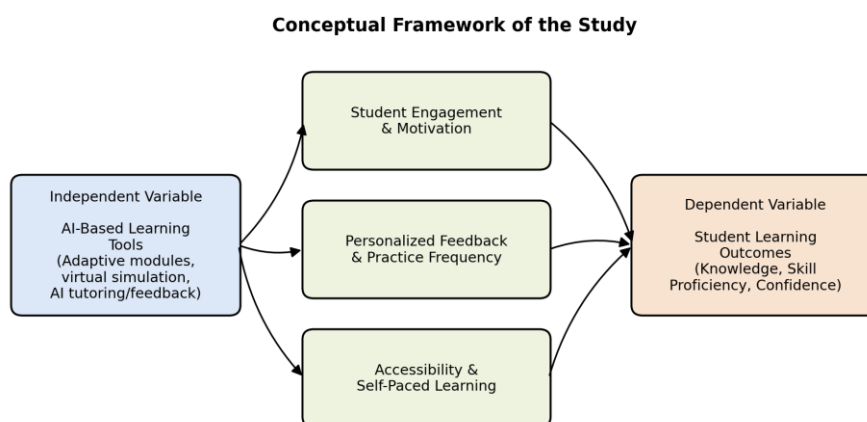


figure 1: conceptual framework linking ai-assisted learning tools to student learning outcomes

3.4 Statistical Tools

Descriptive statistics (means and standard deviations) were computed for each domain by group. Between-group differences were tested using an independent-samples t-test, with statistical significance set at $p < 0.05$. All analyses were performed using standard statistical software.

IV. Results and Discussion

Table 1 summarises the mean assessment scores of the AI-assisted and traditional groups across the three learning-outcome domains. The AI-assisted group recorded higher mean scores than the traditional group in every domain, and the difference was statistically significant ($p < 0.001$) in each case.

table 1: mean learning outcome scores by group and domain

Domain	AI-Assisted Group (Mean %, n=95)	Traditional Group (Mean %, n=93)	Mean Difference	p-value
Theoretical Knowledge	78.4	68.1	10.3	<0.001
Practical Skill Proficiency	74.6	65.3	9.3	<0.001
Clinical Confidence	76.2	63.8	12.4	<0.001
Overall Assessment Score	76.9	65.9	11.0	<0.001

The largest mean difference between groups was observed in clinical confidence (12.4 percentage points), followed by practical skill proficiency (9.3 points) and theoretical knowledge (10.3 points). Figure 2 presents these results graphically.

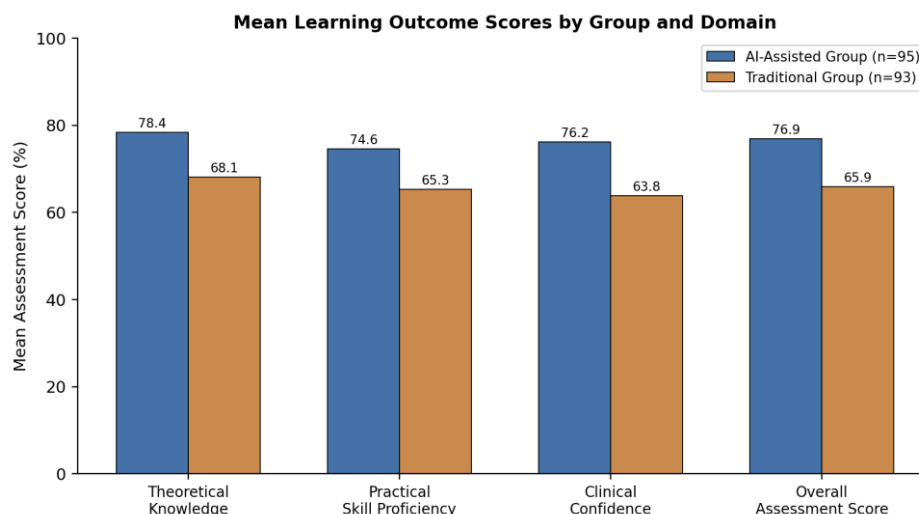


figure 2: mean assessment scores of the ai-assisted and traditional groups across learning domains

The pattern of results is broadly consistent with the wider literature on AI-assisted health professions education, which has generally reported gains in knowledge and skills performance attributable to the repeatable, self-paced practice that AI tools make possible [6]. The comparatively large gain in self-reported clinical confidence in this sample may reflect the value that students place on immediate, non-judgemental feedback during practice, a mechanism also highlighted in reviews of generative AI use in health professional education [7]. At the same time, the magnitude of improvement in practical skill proficiency was smaller than that seen for knowledge and confidence, which aligns with reports that AI-driven tools, particularly those simulating communication or hands-on tasks, have not yet matched the depth of feedback provided by experienced human instructors in every respect [4].

These findings should be interpreted in light of the cross-sectional design, which establishes association rather than causation: students who chose or were assigned to use AI-assisted resources more heavily may have differed from their peers in ways not captured by this study, such as prior academic performance or intrinsic motivation. Longitudinal and randomised designs, of the kind called for in recent meta-analyses of this literature [5], are needed to confirm whether the relationship observed here reflects a genuine causal effect of AI-assisted learning on outcomes.

V. Conclusion

Within the limits of a cross-sectional design, students with greater exposure to AI-assisted learning tools recorded higher mean scores in theoretical knowledge, practical skill proficiency and clinical confidence than peers taught through conventional methods alone, with the largest gain observed in confidence. These findings support the cautious, structured integration of AI-based tools as a supplement to, rather than a replacement for, conventional clinical teaching in allied health training programmes. Institutions considering wider adoption should pair implementation with faculty training and with longitudinal evaluation to confirm that observed gains are sustained and causally attributable to the tools themselves.

Acknowledgment

The author(s) thank the participating training institutes and students for their cooperation during data collection.

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