Effectiveness of Simulation-Based Structured Teaching Programme among B.Sc. Nursing First-Year students regarding knowledge on First Aid: A Pre-Experimental Study at Vydehi Advanced Simulation Academy, Bangalore

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Abstract- Background: First aid constitutes a foundational clinical competency for nursing professionals who are frequently positioned as first responders across healthcare and community settings. Despite its recognised importance in reducing preventable morbidity and mortality, empirical evidence consistently demonstrates that undergraduate nursing students in India and globally exhibit significant baseline deficits in first aid knowledge and practical preparedness. With the World Health Organization estimating 4.4 million injury-related deaths annually—many of which are amenable to timely first aid—the imperative for effective pedagogical strategies is clear. Simulation-based education (SBE), grounded in experiential learning theory, has emerged as a robust evidence-based approach for bridging the gap between theoretical knowledge and clinical application in healthcare education.

Objective: To evaluate the effectiveness of a simulation-based structured teaching programme on knowledge regarding first aid among B.Sc. Nursing first-year students at Vydehi Advanced Simulation Academy, Bangalore.

Materials and Methods: A quantitative pre-experimental one-group pre-test post-test design was employed. One hundred seventy-eight B.Sc. Nursing first-year students were recruited through convenience sampling at Vydehi Advanced Simulation Academy (VASA), Bangalore. Baseline knowledge was assessed using a structured questionnaire comprises of 30 items; A six-hour, three-phase simulation-based structured teaching programme—integrating didactic instruction, demonstration with task trainers and manikins, and integrated simulation scenarios—was delivered. The post-test was administered seven hours post-intervention onset. Data were analysed using paired t-test and Cohen's d effect size ($\alpha = 0.05$).

Results: Pre-test assessment revealed 10.67% with poor, 53.93% with average, and 35.39% with excellent knowledge. Post-intervention, 88.20% attained excellent knowledge, with only 2.25% remaining in the poor category. Mean scores improved significantly from 20.75 (± 4.94) to 26.71 (± 3.63), yielding a mean difference of 5.97 (95% CI: 5.30–6.63). The paired t-test was highly significant ($t = 17.73$, $df = 177$, $p < 0.001$). Cohen's d of 1.37 indicated a very large effect size, substantially exceeding conventional benchmarks for educational interventions.

Conclusion: The simulation-based structured teaching programme demonstrated robust effectiveness in enhancing first aid knowledge among first-year nursing students. The very large effect size underscores the substantive educational impact of integrating simulation modalities into first aid curricula. These findings provide compelling evidence for the systematic adoption of simulation-based first aid education within undergraduate nursing programmes, aligning with the Indian Nursing Council's competency-based education framework.

Keywords: First Aid; Simulation-Based Education; Structured Teaching Programme; Knowledge Assessment;

Nursing Students; Pre-Experimental Study; Task Trainers; Experiential Learning

I. INTRODUCTION

The capacity to deliver competent and timely first aid represents one of the most fundamental yet critically under-addressed competencies within contemporary nursing education. First aid—defined by the International Federation of Red Cross and Red Crescent Societies as the immediate assistance provided to a sick or injured person until professional help arrives—serves as the critical bridge between the onset of an emergency and the initiation of definitive medical care (IFRC, 2016). The efficacy of this initial response frequently determines clinical outcomes: the World Health Organization (2022) estimates that approximately 4.4 million people succumb annually to injuries worldwide, with up to 54% of pre-hospital trauma deaths in low- and middle-income countries being potentially preventable through timely and appropriate first aid interventions (Pellegrino et al., 2020). This staggering statistic transforms first aid education from a peripheral curricular component into a moral and professional imperative for healthcare training institutions.

The Indian subcontinent presents a particularly compelling case for urgent first aid education reform. India accounts for approximately 11% of global road traffic fatality burden, with the National Crime

Records Bureau (2022) documenting over 461,000 road traffic accidents resulting in more than 168,000 deaths in a single year—translating to roughly one road traffic death every three minutes. Beyond road trauma, India faces substantial mortality from burns (estimated 180,000 deaths annually), drowning (approximately 40,000 deaths annually), and occupational injuries (WHO, 2014). The World Health Organization's Global Status Report on Road Safety (2023) has documented that the majority of these deaths occur during the "golden period" before victims reach hospital, primarily due to the absence of bystanders with first aid competency. Nurses, as the largest cadre of healthcare professionals and frequently the first point of clinical contact, bear a particular responsibility in this chain of survival—yet paradoxically, their undergraduate training often provides insufficient grounding in first aid knowledge and skills.

The landscape of existing evidence paints a concerning picture of first aid preparedness among nursing students. A landmark study by Joseph et al. (2015) documented that merely 28% of undergraduate nursing students in South India demonstrated adequate knowledge of basic first aid procedures, with critical knowledge gaps identified in cardiopulmonary resuscitation, fracture immobilisation, and haemorrhage management. These findings have been corroborated by subsequent investigations: Joseph, Kumar, et al. (2014) reported that only 13.8% of medical students in Mangalore demonstrated good first aid knowledge, with the majority exhibiting moderate-to-poor levels despite clinical exposure, while De (2014) documented significant improvement in first aid knowledge among school teachers in Bangalore only after structured teaching intervention, confirming the inadequacy of baseline preparedness. Internationally, Altintas et al. (2005) documented comparable knowledge deficits among first-year university students, indicating that this is not merely an Indian phenomenon but a systemic global concern in healthcare education.

The persistence of these knowledge deficits can be attributed, in part, to the pedagogical approaches traditionally employed in first aid education. Conventional didactic methods—characterised by passive lecture-based instruction, textbook reading, and theoretical examination—fail to adequately address the experiential and procedural nature of first aid competencies (Lateef, 2010). First aid, by its very nature, demands rapid cognitive processing, psychomotor precision, and situational decision-making under stress—competencies that are poorly developed through passive learning alone. This pedagogical mismatch has catalysed a paradigm shift towards simulation-based education (SBE) as a transformative approach in healthcare training.

Simulation-based education creates immersive, realistic learning environments that replicate clinical scenarios with varying degrees of fidelity, enabling learners to practise clinical skills, develop critical thinking, and build procedural confidence without risk to actual patients (Cant & Cooper, 2017). The theoretical architecture of SBE is

firmly grounded in David Kolb's Experiential Learning Theory (1984), which conceptualises learning as a cyclical process comprising four interdependent stages: concrete experience (hands-on encounter with the phenomenon), reflective observation (critical analysis of the experience), abstract conceptualisation (integration of observations into theoretical frameworks), and active experimentation (application of revised understanding to novel situations). In simulation-based first aid education, task trainers and manikins provide the concrete experience, facilitated debriefing enables reflective observation, structured didactic content supports abstract conceptualisation, and scenario-based exercises facilitate active experimentation—thereby engaging all four learning modalities in an integrated pedagogical framework.

Additionally, Bandura's Social Learning Theory (1977) provides complementary theoretical support, positing that learning occurs most effectively through the observation of modelled behaviour, guided practice with feedback, and progressive development of self-efficacy. The demonstration and guided practice components of simulation-based structured teaching directly operationalise these principles, as students observe expert demonstrations, practise under supervision, receive corrective feedback, and progressively develop confidence in their first aid competencies. The synergistic application of these theoretical frameworks creates a pedagogically robust intervention design that addresses cognitive, psychomotor, and affective learning domains simultaneously.

The empirical evidence supporting SBE in healthcare education is compelling and growing. Kim et al. (2016), in a comprehensive meta-analysis of simulation-based nursing education, reported a weighted mean effect size (Cohen's d) of 0.94 for knowledge outcomes, categorised as a large effect. Cant and Cooper (2017) conducted an umbrella systematic review of 25 systematic reviews encompassing over 700 primary studies and concluded that simulation consistently enhances knowledge, clinical skills, and confidence among nursing students. More specifically, within the domain of first aid and emergency care education, Ackermann (2009) demonstrated that simulation-based instruction significantly outperformed traditional lecture-based teaching in improving both knowledge retention and procedural skills. Altintas et al. (2005) reported significant improvement in first aid and BLS knowledge among university students following structured training, while Mehreen et al. (2021) documented that educational school-based interventions significantly improved first aid knowledge among students in Ujjain, India, providing direct evidence from the Indian context.

Despite this growing body of evidence, several critical gaps persist in the literature. First, the majority of studies examining simulation-based first aid education have been conducted in Western healthcare contexts, with limited empirical evidence from Indian institutional settings where resource constraints, cultural factors, and curricular structures differ substantially. Second, few studies have employed a comprehensive multi-phase simulation design integrating didactic instruction, demonstration with task trainers, and immersive scenario-based exercises within a single intervention—most have relied on either didactic teaching with supplementary videos or isolated simulation experiences. Third, there is a paucity of studies reporting effect size measures (such as Cohen's d) alongside traditional significance testing, limiting the ability to assess the practical and educational significance of interventions beyond statistical artefacts of large sample sizes.

The Indian Nursing Council's (2021) revised competency-based undergraduate nursing curriculum has explicitly mandated the integration of simulation-based learning experiences across the programme, creating both an institutional mandate and a pedagogical opportunity for evidence-based curricular innovation. However, the implementation of this mandate requires empirical evidence from Indian institutional contexts to guide decisions regarding simulation design, duration, modality selection, and assessment strategies.

Against this backdrop—the documented global burden of preventable injury-related mortality, the consistently identified knowledge deficits among nursing students, the theoretical robustness and growing evidence base for simulation-based education, and the curricular imperative from the Indian Nursing Council—the present study was conceptualised and executed. The study aimed to evaluate the effectiveness of a comprehensive, multi-phase, simulation-based structured teaching programme on first aid knowledge

among B.Sc. Nursing first-year students at Vydehi Advanced Simulation Academy (VASA), a tertiary simulation centre in Bangalore, South India. By reporting both statistical significance and effect size measures, the study seeks to contribute methodologically rigorous evidence to inform the integration of simulation-based first aid education into Indian undergraduate nursing curricula.

Objectives of the Study

1. To assess the pre-test level of knowledge regarding first aid among B.Sc. Nursing first-year students.
2. To assess the post-test level of knowledge regarding first aid after implementation of the simulation-based structured teaching programme.
3. To evaluate the effectiveness of the intervention by comparing pre-test and post-test knowledge scores using the paired t-test.
4. To determine the practical significance of the intervention through computation of Cohen's d effect size.

Research Hypothesis

H_1: There will be a statistically significant difference between the pre-test and post-test knowledge scores regarding first aid among B.Sc. Nursing first-year students after the implementation of the simulation-based structured teaching programme ($p < 0.05$).

II. MATERIALS AND METHODS

Research Approach and Design

A quantitative research approach with a pre-experimental one-group pre-test post-test design was adopted for this study. This design was selected as it permits the evaluation of an educational intervention within a single cohort where each participant serves as their own control, thereby facilitating within-subject comparison of knowledge levels before and after the intervention (Polit & Beck, 2017). While this design does not control for all threats to internal validity, it is widely accepted in educational research where ethical and practical considerations preclude randomisation and withholding of educational interventions from a control group (Shadish et al., 2002).

Study Setting

The study was conducted at Vydehi Advanced Simulation Academy (VASA), a state-of-the-art tertiary simulation centre located within Vydehi Campus, EPIP Area, Whitefield, Bangalore, Karnataka, India. VASA is equipped with dedicated simulation suites housing high-fidelity and low-fidelity manikins, a comprehensive array of task trainers for procedural skills (including CPR manikins, airway management trainers, wound care trainers, and splinting models), standardised patient examination rooms, multimedia-enabled classrooms, and purpose-built debriefing facilities. The centre provides simulation-based education to nursing, medical, paramedical, and allied health sciences students affiliated with Vydehi Institute of Medical Sciences and Research Centre. The selection of VASA as the study setting was deliberate, as it afforded access to the full spectrum of simulation modalities required for the multi-phase intervention design.

Study Population, Sampling, and Sample Size

The target population comprised all B.Sc. Nursing first-year students enrolled at Vydehi Institute of Nursing Sciences during the academic year 2024–2025. A non-probability convenience sampling technique was employed to recruit participants, as the entire available cohort of first-year students was invited to participate. A total of 178 students met the inclusion criteria and consented to participation, constituting the final study sample.

Inclusion criteria: (a) B.Sc. Nursing first-year students currently enrolled at Vydehi Institute of Nursing Sciences; (b) students present on the day of data collection; (c) students who provided informed written consent.

Exclusion criteria: (a) Students absent on the day of data collection; (b) students who declined to participate; (c) students who had completed any formal first aid certification course (e.g., Red Cross, St. John Ambulance) within the preceding six months.

Data Collection Instrument

A structured knowledge questionnaire was developed by the investigators specifically for this study and comprised two sections. Section A was a sociodemographic data sheet eliciting information on six variables: gender, age, type of family, place of residence, previous knowledge about first aid, and previous exposure to formal first aid training. Section B consisted of 30 multiple-choice items assessing

knowledge across eight domains of first aid: (i) general principles and priorities of first aid; (ii) assessment of scene safety and primary survey; (iii) wound care and haemorrhage management; (iv) fracture, dislocation, and sprain management; (v) management of burns, scalds, and electrical injuries; (vi) poisoning, bites, and stings; (vii) choking and airway obstruction management; and (viii) basic life support and cardiopulmonary resuscitation (CPR).

Scoring was dichotomous: each correct response scored one mark and each incorrect or unanswered item scored zero, yielding a total possible score range of 0–30. Knowledge levels were operationally categorised as: Poor (≤ 14 marks, ≤ 46.7%), Average (15–22 marks, 50.0–73.3%), and Excellent (≥ 23 marks, ≥ 76.7%).

Reliability was assessed through a pilot study conducted among 20 B.Sc. Nursing students (not included in the main study sample) at the same institution. The internal consistency of the instrument was evaluated using Cronbach's alpha coefficient, which yielded a value of $\alpha = 0.84$, indicating good internal consistency and exceeding the minimum acceptable threshold of 0.70 for research instruments (Nunnally & Bernstein, 1994).

Description of the Intervention

The simulation-based structured teaching programme was a comprehensive, six-hour educational intervention meticulously designed in alignment with evidence-based principles of simulation pedagogy, Kolb's Experiential Learning Theory (1984), and Bandura's Social Learning Theory (1977). The programme integrated three sequential and progressively complex phases to create a scaffolded, multi-modal learning experience:

Phase I – Theoretical Foundation (90 minutes): This phase comprised structured classroom instruction addressing the theoretical underpinnings of first aid, including: definitions and scope of first aid; the DRABC (Danger, Response, Airway, Breathing, Circulation) primary survey framework; legal and ethical considerations (Good Samaritan Law in India); principles of triage and casualty prioritisation; and evidence-based protocols for common emergencies. Instruction was delivered using multimedia-enhanced PowerPoint presentations incorporating clinical photographs, procedural algorithm flowcharts, and short instructional video segments demonstrating real-world first aid scenarios. This phase corresponded to Kolb's abstract conceptualisation stage, providing the cognitive foundation upon which subsequent experiential learning was built.

Phase II – Demonstration and Guided Practice (150 minutes): During this phase, the investigators demonstrated key first aid procedures using the task trainers and manikins available at VASA. Procedures demonstrated and practised included: wound assessment, cleaning, and haemorrhage control using wound simulation models; application of triangular bandages, roller bandages, and improvised splints using limb fracture trainers; assessment and management of burns using burn simulation overlays; recovery position and manual airway opening manoeuvres; CPR technique on adult BLS manikins with real-time compression quality feedback; and Heimlich manoeuvre for choking using airway management trainers. Students were organised into groups of 8–10 and rotated through six skill stations, each supervised by a trained simulation instructor who provided real-time corrective feedback and guidance. This phase corresponded to Kolb's concrete experience and Bandura's observational learning and guided mastery components.

Phase III – Integrated Simulation Scenarios (120 minutes): In the culminating phase, student groups participated in four integrated simulation scenarios requiring the coordinated application of multiple first aid competencies in realistic emergency contexts: (a) a road traffic accident scene with multiple casualties requiring triage, haemorrhage control, and fracture immobilisation; (b) a workplace incident involving deep laceration and suspected spinal injury; (c) a domestic emergency involving paediatric choking and adult burn injury; and (d) a witnessed sudden cardiac arrest requiring activation of the chain of survival and BLS delivery. Each scenario was followed by a 10-minute facilitated feedback session using the advocacy-inquiry approach to reinforce key learning points, correct procedural errors, and consolidate clinical reasoning. This phase corresponded to Kolb's active experimentation, enabling transfer of learning to novel clinical situations.

Data Collection Procedure

Following institutional approval, the study was conducted in a single day with a structured timeline: (a) briefing and informed consent (30 minutes); (b) administration of the pre-test questionnaire (30 minutes); (c) implementation of the six-hour simulation-based structured teaching programme; and (d) administration of the post-test using the identical questionnaire, approximately seven hours after the commencement of the intervention. The seven-hour interval between intervention onset and post-assessment was designed to mitigate immediate rote recall effects while remaining proximate enough to capture genuine knowledge acquisition from the educational experience.

Ethical Considerations

Participant confidentiality was maintained through anonymised data coding, and all data were stored securely with access restricted to the research team. Participants were explicitly informed of their right to withdraw at any point without academic penalty.

Statistical Analysis Plan

Data were subjected to both descriptive and inferential statistical analysis. Descriptive statistics (frequency, percentage, mean, standard deviation) were computed to characterise sociodemographic variables and summarise knowledge scores. The paired (dependent samples) t-test was employed to test the significance of the mean difference between pre-test and post-test scores. The practical significance of the intervention was quantified using Cohen's d effect size, calculated as the mean difference divided by the pooled standard deviation (Cohen, 1988). Effect size magnitude was interpreted using Cohen's conventional benchmarks: small (d = 0.2), medium (d = 0.5), large (d = 0.8), and very large (d > 1.0). The 95% confidence interval for the mean difference was computed to quantify the precision of the estimated treatment effect. The level of statistical significance was set a priori at $\alpha = 0.05$. All analyses were performed using SPSS Statistics.

III. RESULTS

Section I: Sociodemographic Profile of Participants

The sociodemographic characteristics of 178 participating B.Sc. Nursing first-year students are delineated in Table 1.

Table 1. Frequency and Percentage Distribution of Sociodemographic Variables Among B.Sc. Nursing First-Year Students (N = 178)

Demographic Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	60	33.71
	Female	118	66.29
Type of Family	Nuclear	146	82.02
	Joint	32	17.98
Age (years)	17	3	1.69
	18	97	54.49
	19	57	32.02
	20	17	9.55
	21	3	1.69
	22	1	0.56
Place of Residence	Urban	102	57.30

	Rural	76	42.70
Previous Knowledge of First Aid	Yes	70	39.33
	No	108	60.67
Previous Formal First Aid Training	Yes	21	11.80
	No	157	88.20

The demographic profile reveals a predominantly female cohort (n = 118; 66.29%), consistent with national patterns of nursing programme enrolment. The modal age was 18 years (n = 97; 54.49%), and the majority belonged to nuclear families (82.02%) and urban backgrounds (57.30%). Of particular relevance to the study's rationale, a striking 60.67% (n = 108) reported having no previous knowledge about first aid, and an even larger proportion—88.20% (n = 157)—had never undergone formal first aid training prior to this intervention. These baseline characteristics substantiate the identified need for systematic first aid education among this population and confirm that the majority of participants commenced the programme from a position of limited prior knowledge.

Section II: Pre-test Knowledge Assessment

Table 2. Distribution of Participants by Pre-Test Knowledge Level Regarding First Aid (N = 178)

Knowledge Level	Score Range	Frequency (n)	Percentage (%)
Poor	≤ 14	19	10.67
Average	15 – 22	96	53.93
Excellent	≥ 23	63	35.39

Note. Maximum possible score = 30. Knowledge categorisation: Poor (≤46.7%), Average (50.0–73.3%), Excellent (≥76.7%).

The pre-test assessment (Table 2) revealed that the majority of students (n = 96; 53.93%) possessed average knowledge, while approximately one-third (n = 63; 35.39%) demonstrated excellent knowledge. A notable 10.67% (n = 19) exhibited poor knowledge. Cumulatively, nearly two-thirds of participants (64.60%) scored at or below the average category, indicating a substantive baseline knowledge deficit warranting educational intervention.

Section III: Post-test Knowledge Assessment

Table 3. Distribution of Participants by Post-Test Knowledge Level Regarding First Aid (N = 178)

Knowledge Level	Score Range	Frequency (n)	Percentage (%)
Poor	≤ 14	4	2.25
Average	15 – 22	17	9.55
Excellent	≥ 23	157	88.20

Note. Maximum possible score = 30. Post-test administered 7 hours after intervention commencement.

Post-intervention assessment (Table 3) demonstrated a transformative improvement in knowledge distribution. The proportion of students achieving excellent knowledge surged from 35.39% to

88.20% (n = 157)—an absolute increase of 52.81 percentage points. Concurrently, the average knowledge category contracted from 53.93% to 9.55% (n = 17), and the poor knowledge category diminished from 10.67% to 2.25% (n = 4). This dramatic redistribution provides compelling visual and statistical evidence of the intervention's effectiveness in elevating the knowledge levels of the overwhelming majority of participants.

Graphical Representation of Knowledge Level Transitions

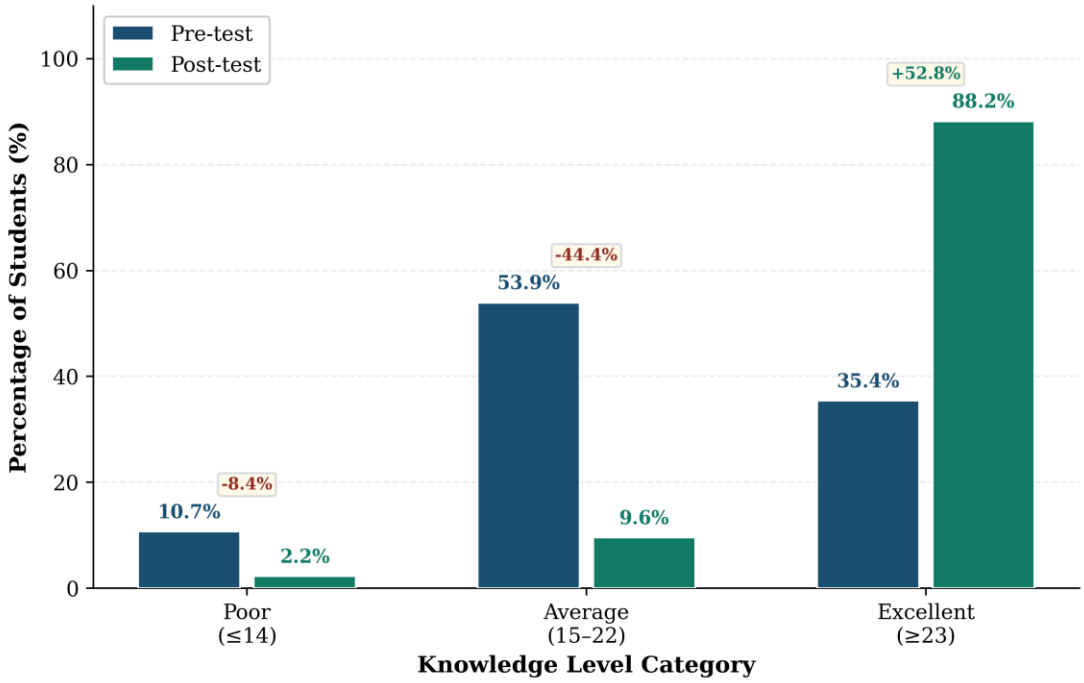

Figure 1. Grouped bar chart comparing pre-test and post-test knowledge level distribution with absolute percentage point change annotations (N = 178).

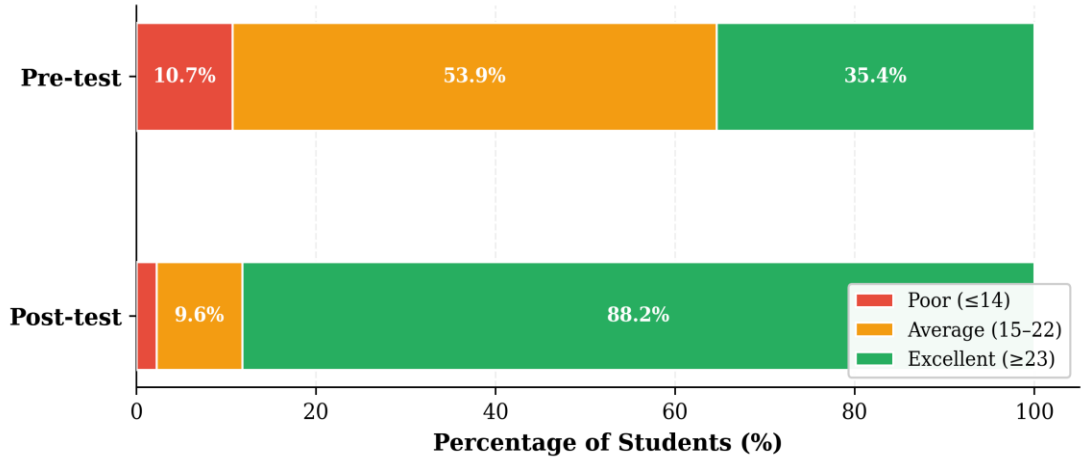

Figure 2. Stacked horizontal bar chart depicting the proportional distribution of knowledge levels before and after the simulation-based structured teaching programme (N = 178).

Section IV: Effectiveness of the Intervention – Inferential Analysis

Table 4. Paired t-Test Comparison of Pre-Test and Post-Test Knowledge Scores with Effect Size (N = 178)

Test	Mean	SD	Mean Diff.	SE	df	t-value	p-value	95% CI	Cohen's d
Pre-test	20.75	4.94							
Post-test	26.71	3.63	5.97	0.34	177	17.73***	<0.001	[5.30, 6.63]	1.37

Note. SD = Standard Deviation; SE = Standard Error of Mean Difference; df = Degrees of Freedom; CI = Confidence Interval. ***p < 0.001. Pooled SD = 4.33. Cohen's d benchmarks: small (0.2), medium (0.5), large (0.8), very large (>1.0).

The paired t-test analysis (Table 4) revealed that the mean post-test knowledge score (M = 26.71, SD = 3.63) was significantly higher than the mean pre-test score (M = 20.75, SD = 4.94), with a mean improvement of 5.97 points (SE = 0.34; 95% CI: 5.30–6.63). The narrow confidence interval indicates high precision of the estimated treatment effect. The computed t-statistic of 17.73 (df = 177) was highly significant at $p < 0.001$, providing unequivocal evidence to reject the null hypothesis and accept H_1: the simulation-based structured teaching programme produced a statistically significant improvement in first aid knowledge.

Critically, the computed Cohen's d of 1.37 (pooled SD = 4.33) indicates a very large effect size, substantially exceeding Cohen's (1988) conventional threshold for large effects (d = 0.80) and surpassing the pooled effect sizes reported in major meta-analyses of simulation-based nursing education (Kim et al., 2016: d = 0.94). This finding confirms that the observed improvement represents not merely a statistically significant but a practically and educationally meaningful enhancement in knowledge attributable to the simulation-based intervention.

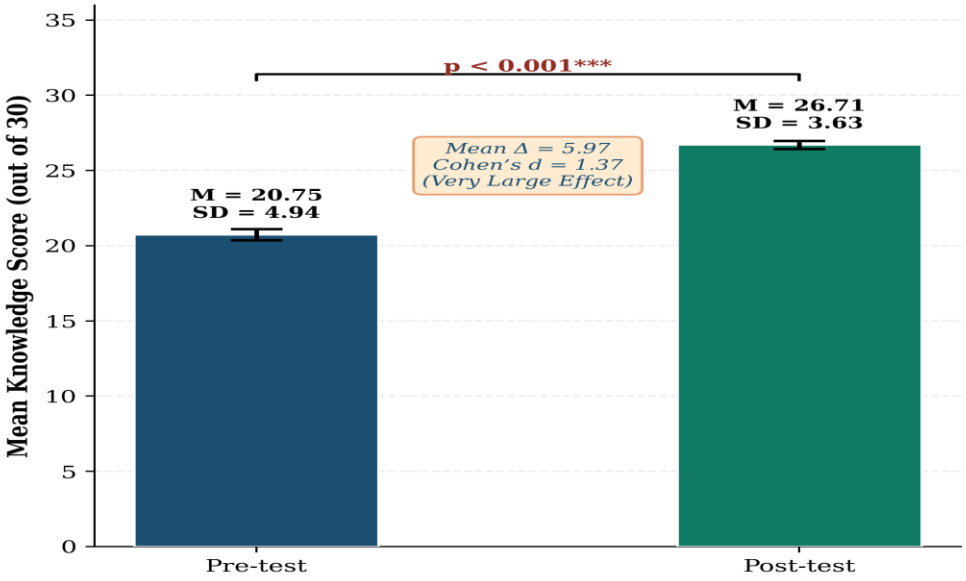

Figure 3. Comparison of mean pre-test and post-test knowledge scores with standard error bars, significance bracket, and effect size annotation (N = 178).

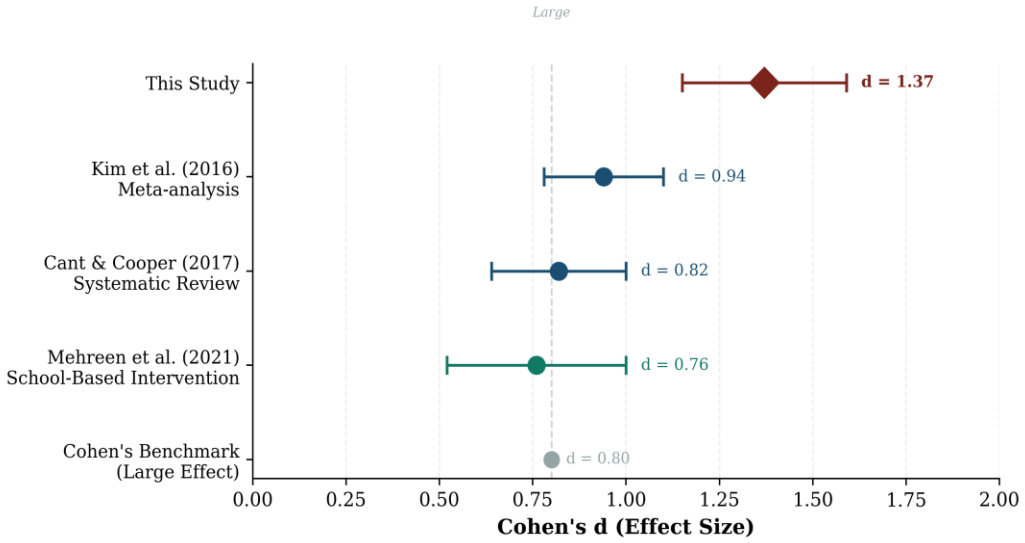

Figure 4. Forest-plot style comparison of the study's effect size (Cohen's d = 1.37) against findings from published meta-analyses and systematic reviews in simulation-based nursing education.

IV. DISCUSSION

The present study was undertaken to rigorously evaluate the effectiveness of a multi-phase, simulation-based structured teaching programme on first aid knowledge among B.Sc. Nursing first-year students at a tertiary simulation centre in South India. The findings yield robust evidence—across multiple analytic indices—that the intervention was highly effective. The following discussion contextualises these findings within the existing evidence base, examines their theoretical and practical implications, and identifies directions for future inquiry.

Baseline Knowledge Deficits: A Systemic Concern

The pre-test results paint a concerning portrait of emergency care preparedness among first-year nursing students. Nearly two-thirds (64.60%) of participants scored at or below the average knowledge category, with 10.67% demonstrating poor knowledge. The finding that 60.67% reported no previous first aid knowledge and 88.20% had no formal training exposure underscores the fundamental inadequacy of pre-university emergency care education in India.

These findings demonstrate a pattern that resonates across the published literature. Joseph et al. (2015) documented that only 28% of nursing students in South India possessed adequate first aid knowledge. Joseph, Kumar, et al. (2014) similarly reported that merely 13.8% of medical students demonstrated good knowledge. De (2014) confirmed knowledge deficits among school teachers in Bangalore. The convergence of these findings—corroborated by Altintas et al. (2005) across international university student populations—suggests that first aid knowledge deficits represent a systemic failure of healthcare curricula rather than an isolated institutional shortcoming. This pattern provides the strongest possible justification for the kind of targeted, evidence-based intervention evaluated in the present study.

Effectiveness of the Intervention: Beyond Statistical Significance

The central finding of this study—a highly significant improvement in mean knowledge scores ($t = 17.73$, $p < 0.001$) accompanied by a very large effect size (Cohen's $d = 1.37$)—provides multi-layered evidence of intervention effectiveness. The inclusion of effect size reporting represents an important methodological contribution, as many nursing education studies report only p-values, which are heavily influenced by sample size and may overstate practical significance (Sullivan & Feinn, 2012). The Cohen's d of 1.37 indicates that the average post-test score exceeded the average pre-test score by 1.37 standard deviations—a magnitude of improvement that

is educationally transformative rather than merely statistically detectable.

This effect size substantially exceeds the pooled estimates reported in landmark reviews of simulation-based nursing education. Kim et al. (2016) reported a weighted mean d of 0.94 for knowledge outcomes across simulation interventions of varying types. Cant and Cooper (2017) similarly reported large effects across their umbrella review. The superior effect size observed in the present study may be attributable to the comprehensive multi-phase design of the intervention, which systematically engaged all four stages of Kolb's experiential learning cycle and Bandura's social learning mechanisms within a single, integrated programme—rather than relying on isolated simulation experiences.

The dramatic redistribution of knowledge levels—from 35.39% to 88.20% in the excellent category—provides additional evidence of effectiveness at the individual student level. This pattern is consistent with Altintas et al. (2005), who reported significant improvement following structured first aid training, and Mehreen et al. (2021), who documented that educational interventions effectively improved first aid knowledge among Indian students. The superior outcomes in the present study may reflect the additive benefit of simulation-based practice over the purely didactic approaches employed in these comparator studies.

The Simulation Advantage: Theoretical and Empirical Perspectives

The multi-phase intervention design warrants specific discussion as a potential explanatory mechanism for the observed effects. Phase I (didactic instruction) established the cognitive scaffolding necessary for subsequent experiential learning, corresponding to Kolb's abstract conceptualisation. Phase II (demonstration and guided practice with task trainers) provided the concrete, embodied experience that is neurobiologically distinct from—and more durable than—abstract knowledge acquisition alone (Lateef, 2010). Phase III (integrated simulation scenarios) required the transfer and application of knowledge in novel, complex situations, engaging higher-order cognitive processes including clinical reasoning, prioritisation, and adaptive decision-making.

This scaffolded progression from theory to demonstration to application mirrors the cognitive apprenticeship model described by Collins et al. (1991), wherein expertise is developed through a sequence of modelling, coaching, scaffolding, and fading. The facilitated feedback sessions following each simulation scenario served the dual purpose of consolidating learning (Kolb's reflective observation) and correcting procedural misconceptions before they became entrenched. The synergy of these pedagogical elements may account for the very large effect size that exceeded meta-analytic norms.

Implications for Nursing Education and Policy

The findings carry several implications of direct relevance to nursing education stakeholders, curriculum designers, and policy makers. First, the documented baseline deficits provide empirical justification for mandating first aid education early in the B.Sc. Nursing programme—ideally during the first semester, before students enter clinical postings where they may encounter emergencies. Second, the very large effect size demonstrates that simulation-based structured teaching is not merely incrementally better than conventional approaches but offers transformatively superior educational outcomes, justifying the investment in simulation infrastructure and faculty training. Third, the findings align with and provide evidence-based support for the Indian Nursing Council's (2021) directive to integrate simulation into competency-based nursing education. Fourth, the multi-phase intervention design evaluated here can serve as a replicable template for simulation-based first aid education at other nursing institutions, with adaptation to local resource availability.

V. LIMITATIONS

The study has several methodological limitations that should be considered when interpreting and generalising the findings. First, the pre-experimental one-group design without a randomised control group limits causal inference, as observed improvements may be partially attributable to confounding factors including the testing effect (pre-test sensitisation), maturation, Hawthorne effect, or history. Second, the convenience sampling approach and single-centre design constrain the external validity and generalisability of findings to other institutional

and geographical contexts. Third, the post-test was administered on the same day (seven hours after intervention onset), precluding assessment of long-term knowledge retention; the observed gains may reflect short-term acquisition rather than durable learning consolidation. Fourth, the study exclusively assessed cognitive knowledge through a multiple-choice questionnaire and did not evaluate psychomotor skill performance, clinical decision-making ability, or attitudinal and confidence-related outcomes. Fifth, the absence of a formal sample size calculation based on a priori power analysis is acknowledged, although the observed effect size and significance level suggest adequate statistical power was achieved. Finally, social desirability bias and the lack of blinding in a single-group design may have influenced post-test responses.

VI. CONCLUSION

This study provides robust empirical evidence that a comprehensive, multi-phase simulation-based structured teaching programme is highly effective in enhancing first aid knowledge among B.Sc. Nursing first-year students. The convergence of a highly significant paired t-test ($t = 17.73$, $p < 0.001$), a dramatic shift in knowledge level distribution (35.39% to 88.20% excellent), a narrow confidence interval for the mean difference (95% CI: 5.30–6.63), and a very large effect size (Cohen's $d = 1.37$) collectively constitute compelling evidence of both statistical and practical significance.

The findings affirm that simulation-based education—when thoughtfully designed to integrate didactic instruction, guided practice with task trainers and manikins, and immersive scenario-based exercises—offers transformative educational outcomes that substantially exceed those typically achieved through conventional pedagogical approaches. Given the documented baseline knowledge deficits, the demonstrated effectiveness of the intervention, and the curricular mandate from the Indian Nursing Council, the systematic integration of simulation-based first aid modules into the early stages of B.Sc. Nursing programmes is strongly recommended as a strategy to enhance emergency preparedness, clinical confidence, and ultimately, patient safety outcomes.

VII. RECOMMENDATIONS FOR FUTURE RESEARCH AND PRACTICE

1. Future studies should employ randomised controlled designs with active control groups (e.g., simulation-based vs. traditional didactic teaching) to establish comparative effectiveness and stronger causal evidence.

2. Longitudinal follow-up assessments at 1-month, 3-month, and 6-month intervals are recommended to evaluate knowledge retention trajectories and identify optimal timing for refresher interventions.

3. Multi-centre studies across diverse institutional and geographical settings should be conducted to enhance external validity and establish the generalisability of findings.

4. Future research should incorporate objective structured clinical examination (OSCE)-based assessment of psychomotor skills alongside cognitive knowledge measurement to capture the full spectrum of first aid competency.

5. Studies examining the dose-response relationship between simulation duration/fidelity and learning outcomes would inform resource-efficient programme design.

6. Investigation of the association between sociodemographic variables and knowledge gain may identify subgroups requiring targeted or differentiated instructional approaches.

7. Simulation-based first aid modules should be integrated as a mandatory component of the first-semester B.Sc. Nursing curriculum at all institutions, with periodic refresher training embedded throughout the programme.

VIII. DECLARATIONS

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