Effectiveness of a 3-Class Scenario-Based Pedagogy in Orthopaedic Nursing Practicum: A Quasi-Experimental Study

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Abstract: _Objective:_ _To evaluate the impact of a 3-Class scenario-based instructional model on undergraduate nursing students rotating through an orthopaedic surgery unit._ _Methods:_ _In this prospective, quasi-experimental study, 97 final-year nursing students who completed their orthopaedic practicum between November 2023 and June 2025 were allocated by rotation block to either a control group (n = 46; conventional preceptorship) or an intervention group (n = 51; conventional preceptorship plus 3-Class scenario-based learning). Core competency (CIRN), problem-solving ability (PSI), and Objective Structured Clinical Examination (OSCE) scores were compared at the end of the rotation._ _Results:_ _Intervention students demonstrated significantly higher post-rotation CIRN (223.67 ± 46.41 vs. 193.37 ± 34.50; P < 0.001) and PSI (81.24 ± 17.55 vs. 71.24 ± 11.27; P = 0.001) scores, as well as superior OSCE performance (90.25 ± 2.15 vs. 87.67 ± 2.87; P < 0.001)._ _Conclusions:_ _Integrating a systematic 3-Class scenario curriculum into orthopaedic nursing education markedly enhanced students' clinical competence, problem-solving capacity, and practical skills, supporting its wider adoption in high-stakes surgical placements._

1. Introduction

The proliferation of arthroplasty and arthroscopic procedures has redefined the competencies expected of undergraduate nurses: advanced procedural dexterity must now be coupled with rapid clinical reasoning and adaptive problem-solving under uncertainty. Conventional preceptorship — demonstration, observation, and delayed practice — efficiently transmits discrete manual steps yet remains insufficient for the iterative translation of pathophysiological knowledge into context-sensitive action within the compressed time frame of a clinical rotation [1]. Scenario-based simulation can bridge this gap by offering a psychologically safe, reproducible milieu for deliberate practice [2]. Prior investigations, however, have centred on isolated encounters; they rarely operationalise a complete learning cycle that integrates pre-class knowledge activation, immersive skill rehearsal, and structured reflection. The 3-Class framework partitions the pedagogical sequence into: (i) Class-1—online, resource-rich preparation driven by authentic clinical tasks; (ii) Class-2 — high-fidelity simulation with immediate, criterion-based feedback; and (iii) Class-3—video-assisted debriefing and metacognitive consolidation. This closed-loop design is predicted to deepen knowledge encoding, refine clinical schemata, and attenuate cognitive load more effectively than traditional models [3]. Empirical validation within orthopaedic nursing education is currently lacking. Here, we conduct a quasi-experimental study to quantify the additive value of the 3-Class scenario curriculum relative to standard preceptorship on nursing students' core competency, problem-solving capacity, and performance in an Objective Structured Clinical Examination (OSCE). Findings will inform evidence-based optimisation of surgical nursing clerkships.

1.2 Design and Participants

We conducted a prospective quasi-experimental study within the orthopaedic surgery unit of Youjiang Medical University Affiliated Hospital. All fourth-year baccalaureate nursing students entering their first orthopaedic rotation between November 2023 and June 2025 were screened for eligibility (n = 97). Students were allocated by rotation block to either the control group (n = 46; November 2023–August 2024) or the intervention group (n = 51; September 2024–June 2025). Baseline characteristics were balanced between groups: control group 31 (67.4 %) females, age 20.67 ± 1.17 years; intervention group 35 (68.6 %) females, age 21.06 ± 1.17 years (χ^2 = 0.02, P = 0.896; t = 1.61, P = 0.110). Inclusion criteria: (i) enrolled in the university's undergraduate nursing programme; (ii) first orthopaedic placement; (iii) written informed consent. Exclusion criteria: cumulative absence > 3 days or withdrawal before study completion.

1.3 Control Group – Standard Preceptorship

Students followed the department's established curriculum: (i) a half-day orientation covering ward policies, electronic health-record access, and aseptic zoning; (ii) a single 45-minute didactic lecture delivered by the lead preceptor, focusing on prevalent orthopaedic pathologies and core procedural techniques; (iii) consecutive clinical shifts under the continuous supervision of a single preceptor holding both a university teaching credential and provincial specialist-nurse certification, during which students assumed responsibility for fundamental bedside care, therapeutic assistance, and documentation; and (iv) summative assessment comprising one fully documented patient chart and an Objective Structured Clinical Examination independently scored by two examiners.

1.4 Intervention Group – 3-Class Scenario-Based Curriculum

Superimposed on standard preceptorship, students completed a closed-loop, three-stage pedagogical cycle grounded in cognitive apprenticeship and deliberate-practice theory.

Class-1 (Pre-class preparation). A faculty triad (lead orthopaedic preceptor + two senior charge nurses) curated a high-yield, peri-arthroplasty scenario. Learning assets — algorithmic care maps, evidence-based rationales, and criterion-referenced rubrics—were distilled into micro-lectures (≤5 min) and interactive slide decks, then disseminated via a dedicated WeChat channel. Three days before each weekly session, students received a paper task booklet; they formed self-directed micro-teams to negotiate role allocation and conduct targeted literature searches.

Class-2 (In-class simulation). (i) Synchronous micro-lecture review with live demonstration of critical procedural steps. (ii) High-fidelity scenario enactment with role rotation (primary nurse, circulating nurse, patient, observer) while faculty captured audio-visual data. (iii) Embedded communication stressors—e.g., a post-operative patient querying the management of surgical drains—to probe situational awareness and adaptive response under time pressure.

Class-3 (Post-class consolidation). (i) Group video-review: students first engaged in scripted self-critique, followed by structured peer feedback and faculty-led micro-debriefing focused on error taxonomy and corrective strategies. (ii) Knowledge extension: students synthesised updated clinical guidelines or seminal research into reflective essays submitted electronically within 48 h, ensuring iterative refinement of mental models.

2. Outcome Measures

2.1 Core Competency (CIRN)

Clinical competence was quantified with the Competency Inventory for Registered Nurses (CIRN), a 58-item, seven-domain instrument validated in Chinese nursing populations (Cronbach's α = 0.89; sub-domains 0.79–0.86) [4,5]. Domains comprise critical thinking / research (10 items), clinical care (9), leadership (10), interpersonal management (8), legal-ethical practice (8), professional development (6), and teaching guidance (7). Responses are captured on a 5-point Likert scale (0 = not competent; 4 = highly competent); higher aggregate and sub-domain scores denote superior competency.

2.2 Problem-Solving Inventory (PSI)

Problem-solving capacity was gauged with the Chinese-revised PSI [6,7]. The 25-item scale spans five dimensions: rational problem-solving (5 items), positive problem orientation (5), impulsivity/carelessness style (4), negative problem orientation (5), and avoidance style (6). Items are rated 1–5, with the last three dimensions reverse-scored; elevated total scores indicate stronger problem-solving aptitude (Cronbach's α = 0.879).

2.3 Objective Structured Clinical Examination (OSCE)

The OSCE provided a high-stakes, simulation-based appraisal of integrated knowledge, clinical reasoning, technical proficiency, and professional comportment [8]. Five standardized stations—each 8 min with 2 min transition—mirrored the peri-arthroplasty trajectory: (i) admission assessment, (ii) post-operative monitoring, (iii) pain management, (iv) mobilisation instruction, and (v) discharge education. Every station embedded one critical psychomotor skill and one unscripted communication challenge enacted by trained simulated patients (e.g., concerns over surgical drains, pain escalation, or activity restrictions). Performance was scored with a 100-point analytic rubric: procedural integrity (0–40), technical execution (0–40), and communication / adaptability (0–20). Two blinded examiners (≥ RN-III credential) independently rated each station; mean scores were averaged across the five stations to yield a composite OSCE result.

2.4 Statistical Analysis

Data were analysed with SPSS 27.0. Continuous variables are presented as mean ± SD; between-group differences were examined with independent-samples t-tests. Categorical variables are reported as proportions and compared using χ^2 tests. Statistical significance was set at two-tailed $P < 0.05$.

3. Results

3.1 Core Competency (CIRN) at Rotation Completion

Students exposed to the 3-Class curriculum achieved significantly higher scores than controls across all seven CIRN domains and on the global scale (all $P < 0.05$; full metrics in Table 1), indicating a robust enhancement of professional competence.

3.2 Problem-Solving Ability (PSI) at Rotation Completion

The intervention cohort outperformed controls on every PSI subscale and on the aggregate score (all $P < 0.05$; Table 2), evidencing superior strategic reasoning and reduced maladaptive response styles.

Table 1: Comparison of CIRN scores between the two groups of nursing students during departmentalization (score, $\bar{x} \pm s$)

Group	Number	Critical Thinking & Research Competence	Clinical Nursing Competence	Leadership Competence	Interpersonal Skills	Legal Ethics Practice	Professional Development	Teaching Guidance	Total Score
Control Group	46	32.17±6.52	29.35±6.11	32.78±6.74	27.59±5.49	27.20±5.28	20.26±3.64	24.02±4.49	193.37±34.5
Intervention Group	51	38.00±7.71	34.9±7.43	38.47±8.34	31.47±6.57	31.16±6.66	22.94±5.17	26.73±5.98	223.67±46.41
T-values		3.993	3.995	3.671	3.141	3.221	2.922	2.495	3.617
P-values		<0.001	<0.001	<0.001	0.002	0.002	0.004	0.014	<0.001

Table 2: Comparison of PSI scores between the two groups of nursing students during departmentalization (score, $\bar{x} \pm s$)

Group	Number	Rational Problem-Solving	Positive Orientation	Impulsive Negligence Style	Negative Orientation	Avoidance Style	Total Score
Control Group	46	13.52±3.42	15.80±2.91	13.37±2.54	13.43±2.83	15.11±3.96	71.24±11.27
Intervention Group	51	15.27±4.67	17.45±4.6	14.9±3.23	15.35±4.46	18.25±5.79	81.24±17.55
T-values		2.092	2.080	2.579	2.500	3.091	3.298
P-values		0.039	0.040	0.011	0.014	0.003	0.001

3.3 Objective Structured Clinical Examination (OSCE)

Mean OSCE performance was markedly higher in the intervention group (90.25 ± 2.15) than in the control group (87.67 ± 2.87, t = 5.043, P < 0.001), translating to an effect size of Cohen's d = 1.02—indicating not only statistical significance but also educational relevance for high-stakes orthopaedic practice.

4. Discussion

Major joint arthroplasty and arthroscopic reconstruction are high-stakes interventions characterised by extensive tissue trauma, substantial haemorrhage risk, and a non-trivial incidence of peri-operative complications [9]. These clinical realities demand that nursing students attain a sophisticated integration of critical thinking, rapid clinical judgement, and ethical decision-making—the cognitive foundations required to discern evolving risk and individualise care [10]. Equally crucial is robust problem-solving capacity, which determines whether novices can dynamically synthesise disparate knowledge domains when confronted with acute pain crises, occult bleeding, or early sepsis. Mastery of procedure-specific psychomotor skills—drain maintenance, evidence-based mobilisation protocols, and prosthetic dislocation prevention — directly modulates patient safety and functional recovery trajectories. Collectively, these imperatives underscore the urgency of a pedagogical paradigm that coherently fuses conceptual learning, cognitive flexibility, and technical precision within the finite span of a clinical clerkship.

In a rigorously controlled quasi-experimental cohort of 97 undergraduate nursing students rotating through orthopaedic surgery at a single academic centre, the 3-Class scenario-based curriculum produced superior outcomes across all primary end-points relative to conventional preceptorship (P < 0.05). These findings corroborate prior evidence that high-fidelity simulation enhances both technical proficiency and clinical reasoning among surgical trainees [2,11], and extend the work of Wang et al. [4], who identified structured practice opportunities as an independent predictor of core competency in vocational nursing cohorts.The scores of PSI dimensions and the total score were consistent with the conclusion of Xu Jianmei, that is, the application of "3-class" situational teaching mode in surgical nursing teaching can significantly improve the problem solving ability of nursing students [12].

The observed effect sizes exceed those reported for single-session or isolated simulations, underscoring the incremental value of embedding a complete "pre-class– in-class–post-class" feedback loop—an operationalisation more faithful to Yang's original 3-Class architecture [3]. Moreover, the intervention not only elevated positive problem-solving dimensions but also significantly attenuated negative problem orientation and avoidant coping styles, aligning with cardiovascular surgery data demonstrating that iterative, problem-centred learning reduces maladaptive responses to clinical uncertainty [7]. Collectively, these results provide robust empirical support for the scalability of the 3-Class paradigm across high-acuity surgical environments.

The 3-Class scenario-based pedagogy demonstrably enhances orthopaedic nursing competency, problem-solving acumen, and OSCE performance. Yet several constraints qualify these findings. First, the quasi-experimental design, with allocation by rotation batch, cannot fully eliminate temporal confounding. Second, outcomes rely on self-reported instruments and a single summative OSCE, both susceptible to social-desirability and context effects. Third, the single-centre cohort limits external validity. Finally, faculty workload and incremental resource demands remain unquantified; future multicentre RCTs with cost-effectiveness analyses are imperative to establish scalability and sustainability.

Competing Interests

The authors declare no competing interests.

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