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Effects of Surgical Anatomy Study Guide-Based Education on the Clinical Performance of Operating Room Students: Catheterization, Patient Transfer, Wound Closure, Instrument Handling, Positioning, and Hemostasis

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ABSTRACT

Introduction: Surgical anatomy underpins every core perioperative skill, yet operating room students often struggle to translate anatomical theory into clinical practice. Targeted study guides that integrate anatomy with procedural workflow may bridge this gap. This study aimed to determine the effects of surgical anatomy study guide-based education on the clinical performance of operating room students across catheterization, patient transfer, wound closure, instrument handling, positioning, and hemostasis.

Material and methods: This quasi-experimental study with a Solomon four-group design included 60 undergraduate operating room students. Over fourteen weeks, the intervention groups received surgical anatomy study guide–based education while controls received conventional teaching. Six procedural skills were assessed before and after using Direct Observation of Procedural Skills (DOPS) and multiple-choice examinations.

Results: Direct observation and feedback times varied across skills, with wound closure requiring the longest observation (14.30 min) and patient transfer the shortest (5.02 min). DOPS scores increased across groups: control (280.91±49.72), control+pretest (319.09±39.30), intervention (359.33±84.13), and intervention+pretest (404.47±70.42). The intervention group scored significantly higher than controls (t=-3.62, df=24, p<0.001; mean difference=85.38).

Conclusion: In conclusion, this study provides evidence that surgical anatomy study guide–based education significantly enhances the clinical performance of operating room technology students across six core perioperative skills, with the greatest benefits observed when the intervention is combined with pretesting.

Introduction

Operating room (OR) education represents one of the most demanding and multifaceted domains within contemporary healthcare training. Surgical technology students must simultaneously master intricate theoretical constructs and execute high-stakes psychomotor tasks within a time-sensitive, high-pressure clinical environment. Unlike general ward or outpatient nursing procedures, perioperative duties demand absolute precision, unwavering aseptic vigilance, and an immediate understanding of human anatomy to safeguard patient outcomes.

Traditional instructional approaches in surgical technology frequently depend on fragmented didactic lectures and passive observational apprenticeships, which leave learners unable to translate abstract anatomical knowledge into real-time intraoperative performance. Consequently, modern surgical education increasingly prioritizes structured, outcome-driven pedagogical frameworks capable of converting complex structural understanding into flawless clinical execution [1].

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The pedagogical integration of surgical anatomy constitutes the cornerstone of competency-based perioperative training. Surgical anatomy differs fundamentally from classic systemic or descriptive anatomy, as it focuses on functional spatial relationships, fascial planes, neurovascular trajectories, and critical boundary landmarks that govern operative safety. When operating room trainees lack a deep comprehension of these spatial orientations, their capacity to anticipate surgical maneuvers, prepare appropriate instruments, and maintain sterile field integrity becomes markedly impaired. Purpose-built educational tools, such as custom-designed study guides, provide codified cognitive scaffolding that enables learners to contextualize anatomical knowledge directly within procedural workflows, thereby strengthening situational awareness and reducing the incidence of preventable perioperative errors [2].

Among foundational perioperative competencies, urinary catheterization stands as a quintessential procedural skill that requires meticulous anatomical insight. Although frequently perceived as a routine entry-level task, urethral catheterization presents considerable anatomical hazards, particularly regarding urethral curvature, sphincteric resistance, and the risk of false passage or traumatic injury in cases of anatomical variation. Operating room students must therefore integrate precise anatomical landmarks with gentle, sterile technique to ensure atraumatic insertion and minimize catheter-associated complications. Competency in this domain is best cultivated through structured educational models that explicitly link urethral and bladder anatomy to the sequential steps of the procedure, reinforcing both safety and confidence [3].

Patient transfer and intraoperative positioning represent equally critical yet frequently underestimated clinical skills in the perioperative setting. Safe transfer of an anesthetized or injured patient requires coordinated body mechanics, an appreciation of spinal alignment, and an awareness of vulnerable pressure points and neurovascular bundles. Improper handling during transfer can precipitate serious complications, including nerve compression, joint injury, pressure ulcers, and even hemodynamic instability. Accordingly, surgical education programs now emphasize evidence-based transfer protocols that integrate anatomical knowledge of the musculoskeletal and neurovascular systems, enabling students to perform safe mobilization while preserving patient dignity and physiological stability [4].

Surgical positioning further exemplifies the inseparable link between anatomy and perioperative safety. Each operative position, whether supine, prone, lateral, or lithotomy, imposes distinct physiological consequences and anatomical risk profiles. Specific positions carry well-documented dangers such as brachial plexus injury, ulnar or peroneal nerve compression, and ocular or respiratory compromise. Optimal positioning thus demands a thorough understanding of anatomical pressure points, joint range of motion, and vascular perfusion dynamics. Educational interventions that embed this anatomical reasoning within positioning protocols equip students to individualize patient placement while proactively preventing position-related injuries throughout prolonged surgical procedures [5].

Wound closure represents a technically exacting skill in which anatomical knowledge directly determines surgical outcomes. Effective closure requires layered approximation of fascia, subcutaneous tissue, and skin, with careful respect for tension, tissue vascularity, and the biomechanical properties of each anatomical plane. Suboptimal suturing technique may lead to dehiscence, infection, cosmetic deformity, or prolonged healing. Consequently, mastery of wound closure extends well beyond simple needle handling; it necessitates an understanding of tissue architecture, wound-healing physiology, and the principles of tension distribution. Structured educational approaches that integrate these anatomical principles have been shown to enhance suture quality and reduce wound-related morbidity among trainees [6].

Instrument handling and sterile technique constitute the practical interface through which anatomical comprehension is expressed intraoperatively. The operating room teems with specialized instrumentation, each designed for specific tissues, planes, and procedural purposes. A student who understands the anatomical rationale underlying instrument selection and manipulation is better positioned to anticipate the surgeon’s needs, pass instruments safely, and maintain the integrity of the sterile field. Conversely, inadequate instrument handling not only disrupts surgical flow but also elevates the risk of contamination and iatrogenic injury. Therefore, modern curricula emphasize the fusion of instrument dexterity with anatomical reasoning, transforming passive tool knowledge into active, anticipatory clinical competence [7].

Hemostasis represents one of the most safety-critical responsibilities delegated within the perioperative team. Effective hemostatic support requires a working knowledge of vascular anatomy, the mechanisms of coagulation, and the appropriate application of mechanical, thermal, and chemical modalities. Operating room students must recognize the difference between capillary oozing and arterial hemorrhage, understand the anatomical sites at elevated bleeding risk, and respond promptly to evolving surgical demands. Deficiencies in hemostatic knowledge can translate into increased blood loss, prolonged operative time, and compromised patient safety. Thus, anatomical education that explicitly addresses vascular structures and bleeding control is indispensable to the development of competent perioperative practitioners [8].

The measurement of clinical performance in health professions education has undergone substantial evolution over recent decades. Contemporary assessment frameworks advocate for competency-based evaluation that captures not only the completion of a task but also the quality, safety, and underlying reasoning of clinical execution. Standardized observational instruments, such as objective structured clinical examinations and validated clinical performance checklists, enable educators to quantify procedural proficiency with acceptable reliability and validity. Within the operating room, however, performance assessment remains challenging due to the dynamic nature of surgery and the difficulty of standardizing real-patient scenarios, highlighting the need for educational models that produce measurable, reproducible gains in psychomotor competence [9].

Evidence increasingly supports the efficacy of structured study guides as a pedagogical instrument across health science disciplines. Study guides function as organized, learner-centered frameworks that consolidate essential content, sequence complex procedures, and direct attention toward high-yield anatomical and technical concepts. When aligned with specific clinical competencies, these guides reduce cognitive load, promote self-directed learning, and enhance the retention and transfer of knowledge to practical contexts. In surgical and perioperative education, anatomically informed study guides have demonstrated particular promise by connecting spatial anatomical understanding with stepwise procedural execution, thereby facilitating a more integrated and durable learning experience [10].

The anatomical foundation of surgical technology education has historically been delivered through conventional lecture and cadaveric or model-based instruction, which, while valuable, often remains disconnected from live clinical application. Students may excel in anatomical examinations yet struggle to apply that knowledge when confronted with the sensory complexity and time pressure of an actual operation. This “theory-practice gap” has been repeatedly identified as a central weakness of traditional curricula and is associated with heightened anxiety, diminished confidence, and suboptimal technical performance among novice trainees. Bridging this gap necessitates innovative educational strategies that deliberately and explicitly integrate anatomy into the workflow of everyday perioperative tasks [11].

A growing body of literature underscores the relationship between targeted educational interventions and improved clinical competency in surgical settings. Programs that incorporate simulation-based training, structured clinical mentorship, and standardized learning materials have reported significant enhancements in procedural skill, adherence to safety protocols, and overall learner self-efficacy. Nevertheless, the majority of these studies have concentrated on medical students, surgical residents, or nursing generalists, with comparatively limited attention devoted to the distinct educational needs of operating room technology students, whose curriculum and scope of practice differ fundamentally from those of other healthcare professions [12].

Despite the recognized importance of surgical anatomy in perioperative education, there remains a notable paucity of rigorously designed studies examining the specific impact of anatomy-based study guides on the clinical performance of operating room students. Existing research has largely explored individual skills in isolation or relied on self-reported outcomes rather than objective, multidimensional assessments of real clinical behavior. Furthermore, few investigations have simultaneously evaluated the breadth of core perioperative competencies, including catheterization, patient transfer, wound closure, instrument handling, positioning, and hemostasis, within a single educational framework. This gap limits the capacity of educators to design evidence-based curricula that are both anatomically grounded and clinically responsive [13].

Given these considerations, the present study was conducted to address this educational gap through the development and implementation of a surgical anatomy study guide specifically tailored to operating room students. The intervention was designed to integrate anatomical knowledge with the practical execution of six core perioperative skills, thereby fostering a unified cognitive and psychomotor learning experience. A structured, objective assessment framework was employed to compare the clinical performance of students who received the study guide–based education with that of their conventionally trained counterparts. Accordingly, this study aimed to determine the effects of surgical anatomy study guide–based education on the clinical performance of operating room students in the domains of catheterization, patient transfer, wound closure, instrument handling, positioning, and hemostasis.

Material and methods

Study Design

This interventional study employed a quasi-experimental design incorporating a Solomon four-group structure. Students from each academic semester were randomly allocated to intervention and control arms, with some groups receiving only pretesting and others only post testing to control for testing effects. The design permitted simultaneous evaluation of knowledge-based and skill-based outcomes across six core perioperative competencies over a structured fourteen-week period.

Sampling

The study population comprised all undergraduate operating room technology students enrolled in the fifth and seventh semesters at the Faculty of Nursing and Midwifery, Tabriz University of Medical Sciences. A census sampling method was applied, enrolling all eligible students (n=60) who met the inclusion and exclusion criteria.

Inclusion and Exclusion Criteria

Students were considered eligible for inclusion if they met three criteria: willingness to participate in the study, active enrollment in either the fifth or seventh academic semester, and current registration in operating room clinical internship units. Conversely, participants were excluded from the study if they failed to attend the posttest or complete all stages of the investigation, did not thoroughly study the guide materials and content among students in the intervention group, or self-reported any contact or exchange of information with intervention-group peers. Given that the original protocol did not comprehensively enumerate all plausible exclusion grounds, several additional criteria were incorporated to safeguard internal validity. Specifically, students were further excluded if they withdrew consent at any point, transferred to another institution or interrupted their studies during the study period, or had a history of prior formal training or employment involving surgical anatomy study guides. Additional exclusions encompassed students with physical or health conditions that prevented participation in clinical skills assessment, those unable to attend the designated clinical placement sites during the scheduled assessment windows, and any student whose DOPS assessment could not be completed by the appointed evaluator owing to scheduling conflicts. These supplementary criteria ensured that the final analytic sample remained homogeneous and that the observed effects could be attributed to the educational intervention rather than extraneous factors.

Procedure

The intervention was implemented over a structured fourteen-week timeline divided into three sequential phases, beginning after the acquisition of legal approvals and access to the study sample. During the first four weeks, a multidisciplinary team comprising faculty members from the departments of operating room technology, anatomy, and medical education convened to develop the surgical anatomy study guide and draft the multiple-choice question (MCQ) and DOPS assessments. Following initial drafting, the instruments were distributed via email to experts in operating room education and medical education for validity and reliability evaluation, and the collected feedback was subsequently reviewed with the principal supervisor and advisory faculty to implement necessary revisions. The final week of this phase was dedicated to the administration of the pretests. During the middle six weeks, the completed surgical anatomy study guide was distributed to students in the intervention groups, who were explicitly instructed not to share the guide or any related information with control-group peers; practical sessions were additionally scheduled to prevent any overlap between intervention and control students, thereby minimizing contamination. The final four weeks were allocated to the administration of the posttests, after which all collected data were reviewed and entered into SPSS version 26 for subsequent analysis.

To assess the knowledge dimension, pretest and posttest examinations were developed in accordance with the learning objectives of the fifth-semester clinical internship “Operating Room Technique I” and the seventh-semester clinical internship “Gastroenterology Technology.” Each examination consisted of 20 four-option multiple-choice questions designed according to Millman’s principles and aligned with the content of the surgical anatomy study guide. The multiple-choice format was selected as the most widely used objective assessment for measuring theoretical knowledge across educational domains, with each item comprising a stem presenting the topic and a set of response options in which one key response was correct while the remaining distractor options were incorrect. Question stems were constructed in interrogative and incomplete-sentence formats, and items were classified according to the three standard response structures: single-correct-answer items with one absolutely correct option, best-answer items in which all options were partially plausible but one was superior, and negative-stem items in which all options except one were correct. These knowledge assessments enabled quantitative comparison of theoretical understanding before and after the educational intervention across all study groups. The skill dimension was evaluated through direct observation of practical performance using the Direct Observation of Procedural Skills (DOPS) instrument. DOPS is a workplace-based assessment method in which the procedural skills of healthcare learners are directly and systematically observed by trained assessors within authentic clinical environments. In this method, an assessor observed each learner performing a procedural skill on a real patient in the clinical setting for approximately 15 to 20 minutes; following observation, each item on the evaluation form was scored using a rating scale, and 5 to 10 minutes were subsequently devoted to providing structured feedback to the learner. The primary objective of this method is to deliver feedback grounded in directly observed performance, and it is particularly well suited to the assessment of short diagnostic and therapeutic procedures or discrete components of more complex procedures. The DOPS instrument employed in this study was designed as a checklist evaluating multiple criteria encompassing theoretical knowledge, practical skill, clinical communication, and professional behavior during the performance of six surgical procedures, thereby allowing participants to improve their performance through structured feedback. Specifically, DOPS was used to measure six clinical skill variables: catheterization, patient transfer, wound closure, instrument handling, positioning, and hemostasis (figure 1).

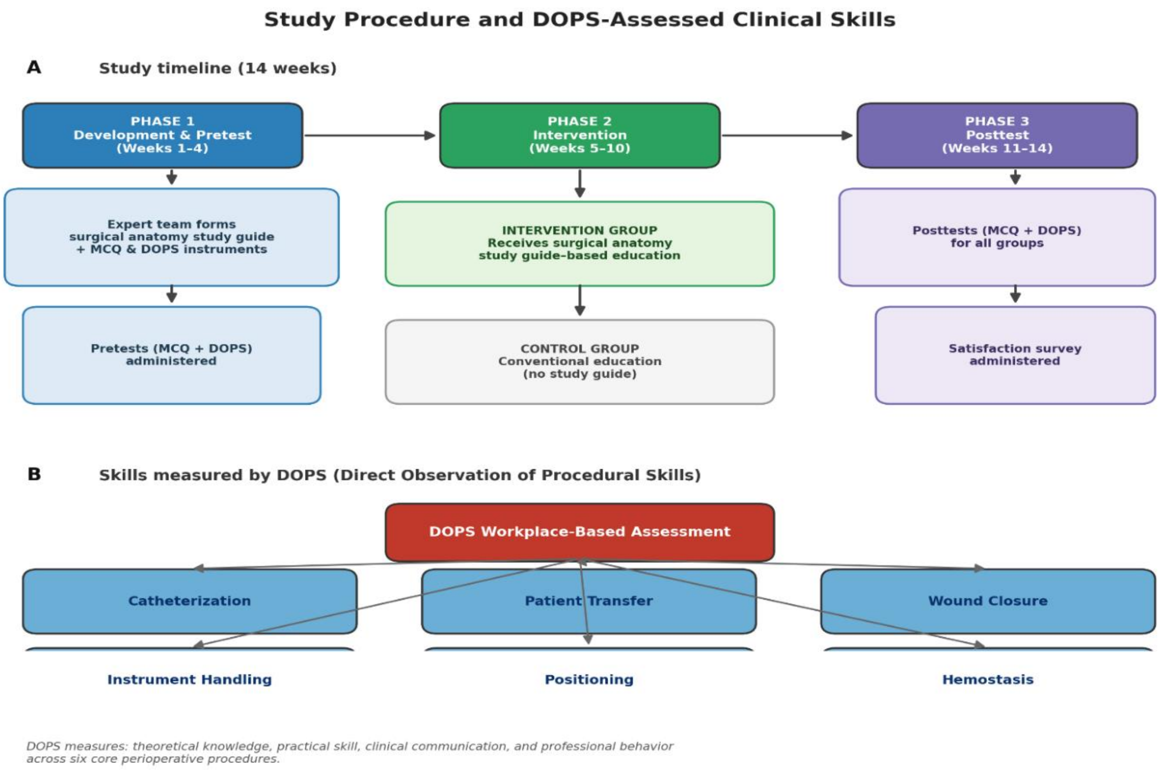

Figure 1. Study workflow and DOPS-based assessment of six perioperative skills in operating room students

Statistical Analysis

Data were analyzed using SPSS software version 26. Descriptive statistics, including frequency distribution tables for age, sex, academic semester, and internship unit, as well as minimum, maximum, mean, and standard deviation for pretest and posttest scores, were generated to characterize the sample. For inferential analysis, the normality of quantitative variables, namely MCQ scores and DOPS scores, was assessed using the Kolmogorov–Smirnov test, which demonstrated that both variables followed a normal distribution, whereas the satisfaction variable exhibited a non-normal distribution. Accordingly, one-way analysis of variance (ANOVA) was used to compare grade point averages across groups, confirming homogeneity of means, and Levene's test was employed to verify the assumption of equality of variances prior to parametric testing. The independent samples t-test was applied to examine differences in mean MCQ and DOPS scores before and after the educational intervention across groups, while the nonparametric Mann–Whitney U test was used to compare students' satisfaction scores, which did not satisfy normality assumptions. All analyses were conducted alongside descriptive statistics, with a significance level set at $P<0.05$.

Ethical Considerations

This study was approved by the Ethics Committee of Alborz University of Medical Sciences under the ethics code IR.ABZUMS.REC.1403.199. All procedures were conducted in accordance with the ethical standards of the institutional research committee and the 1964 Helsinki Declaration and its later amendments. Written informed consent was obtained from all participants prior to enrollment, and participation was entirely voluntary, with students retaining the right to withdraw from the study at any stage without any adverse academic consequences. The confidentiality and anonymity of all collected data were strictly maintained, and no identifying information was disclosed in any report or publication arising from this research.

Results

Across the four study groups, the distribution of students by academic semester showed a slight predominance of the Gastroenterology Technology rotation over Operating Room Technique, accounting for 57.4% and 42.6% of the total sample, respectively. Within groups, the control and intervention arms without pretesting were relatively balanced across semesters, whereas the pretested intervention group included a higher proportion of Gastroenterology Technology students (73.3%). Regarding sex distribution, female students constituted the majority of participants overall (63.8%) and predominated in all groups except the intervention group, in which male students were slightly more frequent (55.6%). Marital status was largely homogeneous across the sample, with most participants being single (93.6%) and only three married students represented across all groups. Academic performance, as reflected by grade point average, was generally comparable among groups, with mean values ranging from 16.17 in the control group to 18.00 in the intervention group and an overall mean of 16.77. Assessment of GPA normality using the Kolmogorov-Smirnov test indicated that the distribution did not significantly deviate from normality (p=0.38); therefore, analysis of variance was considered appropriate for comparing mean GPA across the study groups. Collectively, these baseline findings suggest a broadly comparable distribution of demographic and academic characteristics among the groups, although minor variations in semester composition and sex distribution were observed.

Based on the Direct Observation of Procedural Skills (DOPS) assessments, the mean duration of direct observation and structured feedback varied considerably across the six clinical skills. Observation time was shortest for patient transfer (5.02 minutes) and longest for wound closure (14.30 minutes), while feedback time ranged from 5.98 minutes for patient transfer to 9.23 minutes for instrument handling. A consistent pattern emerged in which the time devoted to observation exceeded the time allocated to feedback for most skills; this discrepancy was most pronounced for wound closure, where observation (14.30 minutes) was nearly twice the duration of feedback (7.79 minutes), and for hemostasis, with 13.40 minutes of observation versus 7.47 minutes of feedback. Similarly, catheterization involved 12.44 minutes of observation and 8.07 minutes of feedback, and instrument handling showed 13.60 minutes of observation against 9.23 minutes of feedback, the latter representing the highest feedback duration recorded. In contrast, patient transfer and positioning exhibited more balanced allocations, with observation and feedback times of 5.02 and 5.98 minutes for patient transfer, and 8.91 and 6.79 minutes for positioning, respectively. Overall, these findings indicate that the total instructional time invested by assessors was greatest for wound closure, instrument handling, and hemostasis, reflecting the greater procedural complexity of these skills, whereas patient transfer required the least time for both observation and feedback (figure 2).

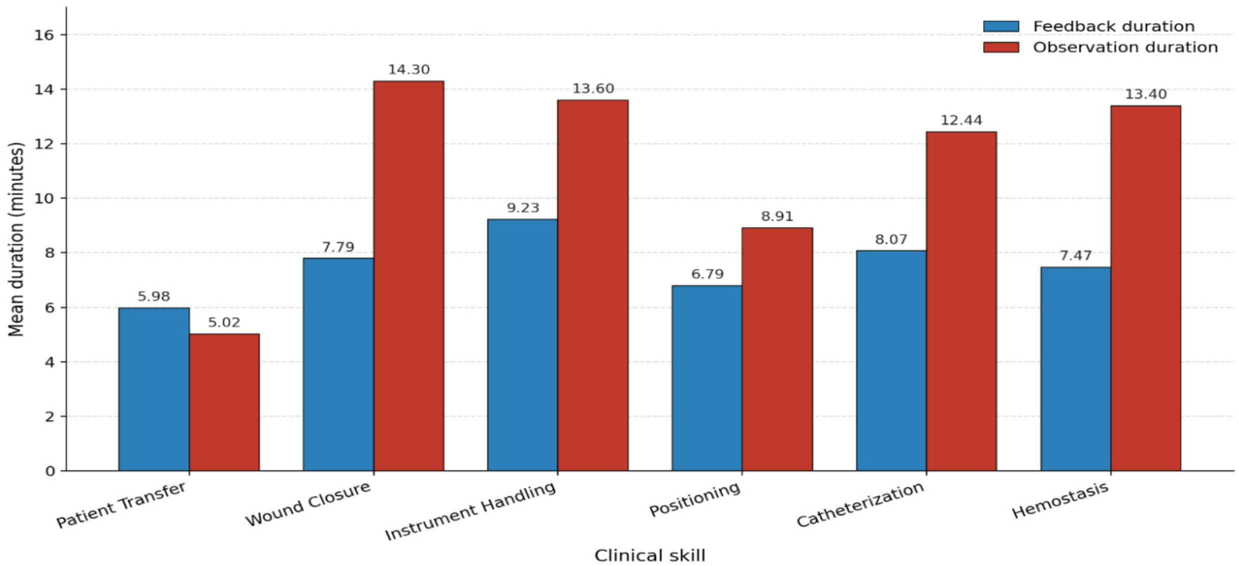

Figure 2. Mean Duration of Observation and Feedback Across Six Clinical Skills Assessed by DOPS

The descriptive analysis of Direct Observation of Procedural Skills (DOPS) scores revealed a consistent upward trend in clinical performance across the four study groups. The control group obtained the lowest mean score (280.91, SD=49.716), followed by the control group with pretest (319.09, SD=39.297), the intervention group (359.33, SD=84.130), and the intervention group with pretest, which achieved the highest mean score (404.47, SD=70.421). These results suggest that students receiving the surgical anatomy study guide–based education performed better on the procedural skills assessment than their conventionally taught counterparts, and that the combination of pretesting and the educational intervention was associated with the greatest improvement. The wide range of scores observed across groups, particularly within the intervention arms, indicates notable individual variability in clinical performance; both intervention groups reached a maximum score of 506, whereas the minimum values (236 to 289) remained relatively close across all groups. Overall, the data demonstrate a gradient of increasing DOPS performance from the control condition through the intervention conditions, with the pretested intervention group showing the most favorable outcomes (table 1).

Table 1. Descriptive Statistics of the DOPS Score by Study Group

Group	Mean	SD	Minimum	Maximum
Control	280.91	49.716	236	364
Control with pretest	319.09	39.297	280	378
Intervention	359.33	84.130	289	506
Intervention with pretest	404.47	70.421	265	506

Prior to hypothesis testing, the normality of the DOPS score distribution was confirmed; therefore, an independent-samples t-test was used to examine the fourth research hypothesis. Levene's test indicated that the assumption of equality of variances between the pretested control and pretested intervention groups was met (F=1.49, p=0.23), allowing the standard t-test interpretation to be applied. The results of the independent-samples t-test revealed a statistically significant difference in mean DOPS scores between the pretested control and pretested intervention groups (t=-3.62, df=24.00, p=0.00), with a mean difference of -85.38 in favor of the intervention group. Accordingly, the null hypothesis of equality of means was rejected at the 0.05 significance level, indicating that the mean DOPS score of operating room technology students who received surgical anatomy study guide–based education differed significantly from that of students who underwent conventional clinical training without the guide. These findings provide empirical support for the fourth research hypothesis, demonstrating that the educational intervention was associated with a meaningful improvement in clinical performance as measured by DOPS.

Discussion

The present study investigated the effect of surgical anatomy study guide-based education on the clinical performance of operating room technology students, as measured by the Direct Observation of Procedural Skills (DOPS) instrument across six core perioperative competencies. The findings revealed a consistent and graded improvement in DOPS scores across the four study groups, with the control group obtaining the lowest mean score (280.91), followed by the control group with pretest (319.09), the intervention group (359.33), and the intervention group with pretest achieving the highest mean score (404.47). This ascending pattern was further corroborated by the independent-samples t-test, which demonstrated a statistically significant difference in mean DOPS scores between the pretested control and pretested intervention groups (t=-3.62, p=0.00), with a mean difference of 85.38 points in favor of the intervention.

The observed superiority of the intervention groups over their conventionally taught counterparts can be attributed to several interrelated pedagogical mechanisms [14]. Structured study guides function as advance organizers that help learners integrate new anatomical knowledge with existing cognitive frameworks [15], thereby reducing extraneous cognitive load and enabling the allocation of working memory resources toward higher-order clinical reasoning [16]. In the context of surgical education, where procedural competence depends on a firm grasp of anatomical relationships, the explicit organization of content facilitates the transformation of declarative knowledge into procedural skill, a transition that is frequently impeded when students rely solely on unstructured or incidental learning [17].

The particularly strong performance of the intervention group with pretest is consistent with the theoretical principles underlying the Solomon four-group design, which was specifically employed to disentangle the effects of the intervention from those of testing [18]. Pretesting has been shown to enhance subsequent learning through the testing effect, whereby the act of retrieval strengthens memory traces and sensitizes learners to relevant content, thereby potentiating the impact of the instructional material that follows [19]. The observed additive benefit in the pretested intervention group therefore likely reflects a synergistic interaction between retrieval-induced learning enhancement and the structured guidance provided by the study guide, rather than a mere artifact of familiarity with the assessment instrument [20].

The variation in time devoted to observation versus feedback across the six skills offers additional insight into the cognitive and technical demands of each procedure. The pronounced observation-to-feedback discrepancy for wound closure, hemostasis, and instrument handling suggests that these competencies require more sustained assessment because they involve multi-step sequences, fine motor coordination, and context-dependent decision-making that cannot be adequately captured through brief observation [21]. Assessors likely extended observation time for these skills to ensure reliable judgments of technical proficiency, whereas the more efficient allocation for patient transfer reflects its comparatively standardized and observable nature [22].

The highest feedback duration recorded for instrument handling is particularly noteworthy and may reflect the central role of correct instrument selection, orientation, and manipulation in the safe execution of numerous surgical procedures [23]. Effective feedback is widely recognized as one of the most powerful influences on student achievement, yet its quality depends substantially on the assessor's ability to identify specific gaps between observed performance and desired standards [24]. The structured nature of DOPS, with its explicit criteria spanning theoretical knowledge, practical skill, communication, and professional behavior, likely facilitated the provision of targeted feedback that translated directly into the performance gains observed in the intervention groups [25].

The substantial individual variability observed within the intervention arms, as evidenced by their wider score ranges and larger standard deviations, merits careful interpretation. This heterogeneity may indicate that the benefits of study guide–based education are not uniformly distributed among learners but are contingent upon individual differences in baseline knowledge, study habits, and self-regulated learning capacity [26]. Students who engage more deeply with the guide and employ effective metacognitive strategies are likely to derive greater benefit, whereas those who approach the material passively may experience more modest gains [27].

The findings of this study align with a growing body of evidence supporting the integration of structured anatomical education into clinical skills training within the operating room context. Prior research in medical education has consistently demonstrated that deficiencies in anatomical knowledge represent a significant barrier to the acquisition of procedural competence and contribute to preventable errors in surgical practice [28]. Curricula that deliberately link anatomical principles to their clinical applications have been shown to enhance both knowledge retention and skill performance, suggesting that the explicit study guide format employed in the present investigation addresses a genuine instructional gap [29].

The use of DOPS as the primary assessment instrument strengthens the validity of the observed effects, as it enables the direct observation of authentic procedural performance in real clinical settings rather than relying on surrogate measures of knowledge [30]. Workplace-based assessment methods such as DOPS are valued for their capacity to capture the integration of knowledge, skill, and professional attitudes that characterizes competent clinical practice, and their structured feedback component is regarded as essential for promoting learning rather than merely documenting performance [31].

Several limitations should be acknowledged when interpreting these results. The relatively small sample size, while adequate for detecting the observed effects, may limit the generalizability of the findings to broader populations of operating room students [32]. Additionally, the use of census sampling within a single institution restricts the external validity of the study, and the reliance on a single assessor or assessment occasion may introduce sources of measurement error that could not be fully controlled [33].

The potential for contamination between intervention and control groups, although addressed through explicit instructions and scheduling precautions, cannot be entirely excluded given the shared academic environment of the participants [34]. Furthermore, the fourteen-week study period, while sufficient to demonstrate short-term effects, does not permit conclusions regarding the long-term retention of the observed skill improvements or their transfer to subsequent clinical rotations [35].

Despite these limitations, the practical implications of this study are considerable for educators and curriculum developers in operating room technology programs. The findings suggest that the deliberate design and distribution of structured surgical anatomy study guides represent a low-cost, scalable intervention that can meaningfully enhance the clinical performance of students across a range of procedural competencies [36]. The integration of such guides into clinical internship curricula may help standardize the educational experience of students and reduce the variability in learning outcomes that arises from differences in clinical placement opportunities and preceptor availability [37].

Future research should examine the sustained effects of study guide–based education over longer follow-up periods and across multiple institutions to establish the robustness and generalizability of these findings [38]. Longitudinal investigations would be particularly valuable in determining whether the performance advantages observed at the end of the intervention persist during subsequent clinical practice and whether they translate into improved patient outcomes [39].

Additional studies might also explore the differential impact of the intervention on individual skills, given the observed variation in instructional time and performance patterns across the six competencies [40]. Identifying which skills benefit most from structured anatomical guidance could inform the targeted allocation of educational resources and the refinement of study guide content to address specific areas of student difficulty [41].

Conclusion

In conclusion, this study provides evidence that surgical anatomy study guide–based education significantly enhances the clinical performance of operating room technology students across six core perioperative skills, with the greatest benefits observed when the intervention is combined with pretesting. The structured integration of anatomical knowledge with clinical skills training, delivered through a well-designed study guide and reinforced by structured DOPS feedback, represents an effective pedagogical approach for improving procedural competence in this population.

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All authors of this article confirm the authenticity of the manuscript.

Conflicts of interest

The authors declare that they have no competing interests.

Disclosure Statement

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Authors' Contributions

All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

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