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From Feedback to Performance: Structured Reflection Enhances Skill Development and Reflective Thinking in Medical Students

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Abstract

Background:

While feedback-literate learners demonstrate the capacity to utilize feedback for behavioral modification, the specific role of structured reflection in procedural skill acquisition remains underexplored. This study examines how systematic reflection on feedback influences both practical skill development (suturing competency) and reflective ability in medical education, addressing a critical gap in skills-based training research.

Methods:

A quasi-experimental, normalized controlled trial was conducted from 2021-2023 with 75 medical trainees at Shahid Beheshti Hospital, Kashan University of Medical Sciences. The participants were nonrandomly assigned to the intervention (n=37) and control (n=38) group. The intervention group participated in a structured reflection workshop based on the Atkins model (comprising description, analysis, and action planning) prior to the suture workshop, whereas the control group proceeded directly to the suture workshop without reflective training. Both groups received identical instructional content and feedback from the instructor and assistants; however, only the intervention group engaged in a structured reflective exercise on the feedback received. The outcome measures included practical skill proficiency, assessed via a standardized 19-item checklist, and reflective ability, evaluated via the reflective ability rubric (RAR). To ensure reliability, two independent raters scored all the assessments. Data analysis was performed via independent t tests and Pearson correlation in SPSS.

Results:

Compared with the control group, the intervention group demonstrated significantly superior performance in practical skills, with mean scores of 18.43 ± 1.77 versus 15.03 ± 2.79, respectively ($p < 0.001$). Reflective ability assessment revealed a mean score of 3.73 ± 0.99 in the intervention group, with a strong positive correlation observed between reflective ability and practical skill performance ($r = 0.936$, $p < 0.001$). Subgroup analyses confirmed the robustness of these findings, showing consistent benefits of reflection training across all participants regardless of previous suture workshop experience ($p = 0.34$ for interaction) or gender ($p = 0.57$).

Conclusions:

This study demonstrates that structured reflection on feedback significantly enhances both procedural skill acquisition and reflective ability in medical trainees. The strong correlation between these competencies highlights the critical role of reflection in clinical learning. These findings support the systematic integration of guided reflection into skills training curricula to optimize educational outcomes. Future research should explore the impact of feedback-driven reflection on various procedural skills and assess its long-term effects on clinical performance.

Introduction

Reflection and feedback are closely intertwined educational principles, both of which are widely acknowledged for their crucial functions in fostering self-awareness, enhancing clinical competence, and strengthening professional development (1, 2). Reflection can be understood as a metacognitive process that may occur before, during, or after an experience. Its purpose is to deepen one's understanding of personal and interpersonal dynamics within a given context such as when receiving feedback on procedural performance(3, 4). Feedback, in turn, often acts as the catalyst that triggers reflection. In medical education, learners who are "feedback literate" that is, those who can understand, evaluate, and effectively use feedback to improve their learning are better able to interpret and apply feedback in ways that modify their behavior. This notion aligns with the cyclical model of reflection proposed by Atkins (5). However, despite the recognized importance of this process, little is known about how reflection on feedback specifically contributes to procedural skill acquisition.

Atkins' model delineates five progressive phases: Awareness, Description, Analysis, Evaluation, and Identification of future actions (6). Through this structured pathway, learners revisit prior encounters, systematically gather and examine relevant information, and reinterpret it within the present context(7). Feedback is a critical component of this process(8). In the medical literature, feedback is metaphorically referred to as the "heart" of learning (9). Students often report a deficit in learning clinical skills and identify that constructive feedback can make the acquisition process highly engaging and effective(10). When students receive structured feedback, they are more likely to engage in active self-evaluations and better integrate learning experiences (11).

Models of structured reflection, therefore, do more than reinforce the technical skills they nurture clinical reasoning, enhance comprehension, and foster more durable learning than surface-level approaches do(12). Reflection is indispensable for self-regulated learning and lifelong professional development, serving as a cornerstone in advancing communication, clinical judgment, and expertise within healthcare professions(13). Moreover, sustained and deliberate reflection is increasingly regarded as a defining hallmark of scholarly practice(14).

To unlock the full educational benefits of reflection, however, its theoretical underpinnings and practical application must be clearly understood(15). Without scaffolding, learners often fall back on unstructured reflection, which tends to generate shallow observations rather than meaningful insights(16). Wald and colleagues, for example, reported in a 2009 study that guided reflection combined with structured documentation significantly enriched both the depth and quality of reflective writing(17).

Although students may initially find reflective practice demanding(18), sustained engagement can lead to increased confidence, skill development, and professional competence(19). For reflection to be genuinely effective, it must transcend simple task review and instead embody critical, purposeful inquiry that leads to tangible cognitive and behavioral growth(20, 21). In the surgical field, where precision and coordination are paramount, reflection has become an invaluable tool for learning(22). The complex nature of surgical work, from preparing equipment to orchestrating group interactions, highlights the necessity of reflective practice for maintaining security and efficacy(23). Modern surgeons must

seamlessly combine their technical knowledge with professional judgment and effective communication to confront complex clinical challenges(24). Therefore, reflection serves as an essential method for lifelong learning and surgical competency, enabling practitioners to assess past performance and improve future clinical outcomes(25).

Recent evidence underscores that feedback and reflection are mutually reinforcing processes that enhance surgical and clinical training. While reflection fosters self-regulated learning and critical evaluation of performance, feedback provides external perspectives that help learners recalibrate and refine their reasoning and skills. A 2025 randomized controlled trial demonstrated that integrating individualized feedback with structured reflection significantly improved deep learning outcomes among medical students compared with reflection alone(26). Similarly, innovations in residency training, such as structured feedback agreements and competency-based reforms, have shown measurable improvements in resident satisfaction and progression, highlighting feedback as an essential tool for fostering reflective practice(27). Together, these findings suggest that embedding feedback-driven reflection within surgical education is not merely complementary but necessary to cultivate higher-order learning and sustained professional growth.

Despite the growing recognition of reflection as a critical component of medical education, evidence remains limited regarding its specific impact on procedural skill acquisition. While structured reflection has shown promise in enhancing clinical reasoning and professional development, its measurable effects on hands-on technical competencies, particularly in fundamental skills such as suturing, have not been thoroughly investigated. This study addresses this gap by evaluating whether structured reflection training, grounded in the Atkins model, improves both practical suturing skills and reflective ability among medical trainees. Additionally, it examines the relationship between reflective ability and technical performance while exploring potential moderating factors.

Methods and Materials

Study Design and Participants

This quasi-experimental, non-equivalent control group design involving 75 surgical rotation trainees was conducted from 2021 to 2023 at Shahid Beheshti Hospital, Kashan University of Medical Sciences. The participants were nonrandomly allocated to either an intervention group (n = 37) receiving structured reflection training or a control group (n = 38) receiving standard training. This study examined how systematic reflection on feedback impacts learning outcomes in suture training. The intervention group participated in a pretraining reflection workshop and conducted guided post feedback reflections, whereas the control group completed the suture training without structured reflection components. Both groups were provided with similar training conditions, including comparable clinical settings, resources, and supervision, to enhance the consistency of the learning environments. For the control group, the suture workshop was held on a separate day but at the same time of day as the intervention group. The venue, workshop format, and required instruments were the same for both groups, and instruction as

well as feedback were delivered by the same faculty member, residents, and interns. Importantly, the examiner who assessed the outcomes was blinded to the group assignments (Fig. 1).

Pre-Intervention phase

The pre-intervention preparation consisted of a structured reflection training workshop grounded in the five-stage Atkins reflective model **Awareness, Description, Analysis, Evaluation, and Identification of future actions** designed to enhance participants' reflective ability (Fig. 2). The workshop was delivered as a two-hour, face-to-face, interactive session held two days before the suture training. It included theoretical instruction, guided practice, and group discussions, designed to actively engage students in the reflective process.

Participants were provided with a reflection guide booklet, standardized templates covering all five Atkins stages, and a 13-minute instructional video, ensuring consistent and uniform application of the reflective practice.

During the **awareness phase**, trainees were introduced to the purpose and value of structured reflection in clinical skills training. Facilitators encouraged them to recognize their existing assumptions, prior experiences, and baseline understanding of suturing procedures, helping them develop an informed mindset before engaging in reflection.

In the **description phase**, participants learned to objectively document their suture training experiences by detailing procedural steps, contextual factors, and critical incidents that warranted deeper exploration. The **analysis phase** focused on identifying underlying factors contributing to performance strengths and weaknesses, where facilitators provided exemplar cases and guided questioning to promote deeper analytical reasoning.

The **evaluation phase** required trainees to critically assess the effectiveness of their actions, decision-making processes, and responses during the procedure. Participants compared expected and actual outcomes, considered the impact of their choices, and reflected on both positive and challenging aspects of their performance. Finally, in the **identification phase**, students developed specific, targeted strategies for improvement such as enhancing technical precision, improving procedural workflow, or refining decision-making. Emphasis was placed on the clinical relevance of these action steps and their transferability to future practice.

As part of the workshop activities, students composed a guided reflective narrative during the session, which was followed by voluntary presentations and facilitator feedback. Additional time for questions and clarification ensured that participants fully understood each reflection stage.

Quality assurance measures included facilitator-led group discussions, exemplar-supported teaching, structured timing for each reflection stage, and interactive group exercises to maintain engagement. All

workshop components were pilot tested and refined to ensure clarity, consistency, and educational effectiveness.

Intervention Group

This study investigated whether structured reflection on feedback enhances both practical suturing skills and reflective ability in medical trainees. The intervention group participated in a supervised suture training session in the clinical skills laboratory, where a faculty surgeon, assisted by residents and interns, provided hands-on instruction in simple and horizontal mattress suturing techniques. Feedback was delivered immediately in a structured verbal format that began with recognition of strengths, followed by targeted suggestions for improvement, and was tailored to individual performance while often shared in group settings to maximize collective learning. After the session, participants completed structured reflections using standardized templates and guidelines introduced during the pretraining workshop. These reflections, focused specifically on horizontal mattress suturing, were submitted within one week and anonymized prior to evaluation to maintain confidentiality. Two trained raters independently evaluated the reflections via the validated reflective ability rubric (RAR), with interrater reliability established through calculation of the kappa coefficient. This rigorous assessment protocol ensured objective measurement of reflective ability while maintaining methodological consistency.

Control Group

The control group participated in the same suture training workshop within the same clinical environment, utilized equivalent resources and received comparable supervision to maintain consistency with the intervention group's training conditions. These participants received standard performance feedback but were not instructed to engage in any structured reflection activities. This study design created a controlled comparison where the sole experimental variable was the implementation of guided reflection, enabling isolation of its effects on both procedural skill acquisition and reflective ability development. The standardized conditions across groups ensured that the observed differences in outcomes could be reliably attributed to the reflection intervention rather than to the environmental or instructional variables.

Measurements

The primary outcome measures in this study were reflective ability and practical skill performance in suturing and were evaluated via validated tools to ensure reliability and objectivity.

Reflective Ability

Reflective ability was measured via the reflective ability rubric (RAR)(28), which evaluates reflective writing across six levels

- Description of the situation without insights (1 point)
- Identification of lessons learned (2 points)
- Critical judgment of the experience (3 points)
- Providing reasons or examples (4 points)
- Analysis of influencing factors (5 points)
- Evidence of behavioral change (6 points)

Two independent evaluators demonstrated strong agreement in scoring reflective writings, with Evaluator 1 assigning a mean score of 3.70 (SD = 0.99) and Evaluator 2 assigning 3.77 (SD = 1.04). Statistical analysis confirmed no significant difference between their ratings ($t = -1$, $df = 29$, $p = 0.326$), indicating high interrater reliability and supporting the robustness of the reflective ability assessments in this study.

Practical skill performance

Practical skill performance was assessed via a 19-item task-specific checklist developed on the basis of standard surgical textbooks (e.g., *Schwartz's Principles of Surgery*) and adapted from validated assessment tools such as the suturing checklist proposed by Guni et al. (2018). The checklist evaluated key technical domains, including instrument handling, needle positioning, and the knot-tying technique(29, 30).

We utilized a task-specific suturing checklist similar to that developed by Guni et al. (2018), which consisted of 23 procedural steps for needle driving and knot tying. The tool demonstrated strong internal consistency (Cronbach's $\alpha = 0.87$ for needle driving; 0.736 for knot tying), effectively discriminated between novice and expert users ($P < 0.005$), and showed significant concurrent validity with the GEARS scores ($r = 0.613$, $P < 0.005$)(29).

Each item was scored as 0 (not performed) or 1 (performed correctly), with one complex item weighted up to 2 points, for a maximum possible score of 20 points. Assessments were conducted one week after training in a clinical skills lab, with participants completing sutures on simulated models under the observation of a faculty member and a surgical resident, both of whom were blinded to the participants' group assignments to ensure objectivity.

Data analysis

The data were analyzed via SPSS version 22, which employs both descriptive and inferential statistical methods. Descriptive statistics included means and standard deviations for continuous variables and frequencies and percentages for categorical variables. Normality testing was conducted via the Kolmogorov–Smirnov test to assess the data distribution. For comparative analysis, the independent t test was used to compare means between groups for normally distributed data, whereas the Mann–Whitney U test was applied for nonnormally distributed data. Additionally, the Pearson correlation

coefficient was calculated to explore the relationship between reflective ability and practical skill scores in the intervention group. A p value < 0.05 was considered statistically significant, ensuring robust and reliable findings.

Results

Demographics and baseline characteristics of the participants

The intervention (n = 30) and control (n = 38) groups demonstrated comparable baseline characteristics, with no statistically significant differences in demographic or academic measures. The sex distribution was balanced between groups (40% male in the intervention group vs 52.6% in the control group, p = 0.30), as were the mean age (24.05 ± 2.38 vs 23.57 ± 1.79 years, z = 0.772, p = 0.44) and academic performance (GPA 15.72 ± 1.08 vs 16.03 ± 0.77, t=-1.309, p = 0.195). Prior suture workshop experience was similar (56.7% in the intervention group vs 71.1% in the control group, p = 0.21). This equivalence in baseline variables confirms that the groups were properly matched before the intervention, supporting the internal validity of subsequent outcome comparisons (Table 1).

Table 1
Baseline characteristics of the participants

Variable	Intervention Group (n = 30)	Control Group (n = 38)	p value	
Gender (Male/Female)	12 (40%)/18 (60%)	20 (52.6%)/18 (47.4%)	0.30	
Mean Age (SD)	24.05 (2.38)	23.57 (1.79)	0.44	Z = 0.772
Mean GPA (SD)	15.72 (1.08)	16.03 (0.77)	0.195	t = -1.309
Prior similar Suture Workshops	17 (56.7%)/13 (43.3%)	27 (71.1%)/11 (28.9%)	0.21	

The comparison of demographic and baseline variables, including sex, age, GPA, and prior workshop experience, indicated that there were no significant differences between the intervention and control groups *at baseline* (p > 0.05).

This equivalence confirms that both groups were well matched at baseline, thereby strengthening the study's internal validity and minimizing the risk of confounding effects on subsequent outcomes.

Reflective ability

The intervention group's reflective ability was evaluated via the reflective ability rubric (RAR), which has a maximum possible score of 6 points. The participants achieved a mean reflective ability score of 3.73

(SD = 0.99), demonstrating developing but variable reflective skills. Most significantly, we identified a strong positive correlation between reflective ability and practical skill performance ($r = 0.936$, $p < 0.001$), indicating that higher reflective ability was closely associated with superior technical competence (Table 2).

Table 2
Reflective ability scores and correlations with practical skills in the intervention group

Assessment Metric		p value
Maximum possible RAR score	6	-
Mean reflective ability score (SD)	3.73(0.99)	-
Pearson correlation (R)	0.936	$p < 0.001$

RAR = Reflective ability rubric. The table shows the intervention group's reflective performance and a statistically significant correlation with practical skill acquisition.

In the intervention group, the mean reflective ability rubric (RAR) score indicated a developing but variable reflective ability, underscoring individual differences in metacognitive engagement despite uniform training. The very strong positive correlation between reflective ability and practical skill performance suggests that reflective engagement markedly contributes to suturing competency. Learners with higher reflective scores tended to perform better on practical assessments, which is consistent with models of feedback-integrated learning and self-regulated practice.

Practical skill performance

The intervention group demonstrated significantly higher practical skill scores (18.43 ± 1.77) than the control group did (15.03 ± 2.79), with this 3.4-point difference being statistically significant ($z = -5.094$, $p < 0.001$). This robust finding indicates that structured reflection on feedback substantially enhances suturing skill acquisition in medical trainees. Stratified analyses of practical skill performance by sex and prior suture training experience. Both male and female participants in the intervention group demonstrated significantly higher scores than their control group counterparts did ($p < 0.001$ for both comparisons). Similarly, the reflection intervention showed benefits regardless of prior suture training experience, although the effect size was greater among previously trained participants (mean difference 3.89 vs 2.53 points) (Tables 3 & 4).

Table 3
Mean practical skill scores (SD) by study groups with statistical comparison

Group	Mean Score (SD)	p value	z
Intervention (n = 30)	18.43 (1.77)	< 0.001	-5.094
Control (n = 38)	15.03 (2.79)		

The intervention group that received structured reflection had significantly better suturing skills than did the control group. This clear difference suggests that reflecting on feedback leads to real and meaningful improvements in procedural skills. The size of this improvement was both statistically significant and educationally important, reinforcing the value of incorporating structured reflection into clinical training.

Table 4
Comparative analysis of practical skill scores by gender and prior suture training experience

Characteristic	Group	Mean Score (SD)	p value	t value	df
Gender					
Male	Intervention	18.42 (1.08)	0.002	-	-
	Control	15.95 (2.33)			
Female	Intervention	18.44 (2.15)	< 0.001	-	-
	Control	14.00 (2.97)			
Prior Experience					
No training	Intervention	18.08 (2.32)	0.018	-2.565	22
	Control	15.55 (2.50)			
Had training	Intervention	18.71 (1.21)	< 0.001	-5.197	42
	Control	14.82 (2.90)			

Stratified analyses revealed consistent advantages of the intervention across key subgroups. Both male and female participants in the intervention group showed superior performance relative to their control counterparts. While the intervention was effective regardless of prior suturing experience, the effect size was greatest among those who had previous exposure. This pattern suggests that structured reflection not only supports skill acquisition in novices but also enhances refinement and performance optimization in more experienced trainees.

Discussion

The findings of this study demonstrate that structured reflection on feedback significantly enhances the acquisition of suturing skills among medical trainees. The intervention group, which engaged in guided reflection, achieved a mean practical skill score markedly higher than the control group's score. This difference, representing an improvement in performance, underscores the pedagogical value of incorporating reflective practice into procedural training. These results align with the literature emphasizing reflection as a metacognitive strategy that strengthens the integration of theoretical knowledge and clinical application(31, 32).

The findings of this study demonstrate that structured reflection on feedback significantly enhances the acquisition of suturing skills among medical trainees. The intervention group, which engaged in guided reflection activities, outperformed the control group in terms of practical skill proficiency, and this improvement was statistically significant. This performance gap underscores the pedagogical value of incorporating reflective practice into procedural training.

These results align with those of a randomized controlled trial in which students who utilized self-assessment checklists prior to practice sessions showed faster acquisition and greater accuracy in basic suturing(33). Similarly, another intervention study reported notably higher post-training skill levels in learners exposed to structured reflective practices than in those who did not. These converging findings further support the effectiveness of reflection-based strategies in enhancing procedural competency in clinical education(34).

Structured feedback and reflection significantly enhance self-assessment accuracy and learning regulation during clinical skill training in medical students(35).

By systematically measuring the influence of reflection on hands-on technical skills through objective assessment tools, this study fills an important void in the evidence base for competency-based medical education.

Subgroup analyses further illuminate the intervention's efficacy. Both male and female trainees exhibited significant skill improvement, suggesting that structured reflection benefits learners regardless of gender. The more pronounced effect among female participants may indicate that reflective practices help mitigate potential disparities in technical skill development, warranting further investigation. Additionally, while the intervention enhanced performance across all experience levels, its impact was greatest among trainees with prior suture exposure. This finding resonates with Kolb's experiential learning theory, wherein reflection optimally reinforces and refines existing competencies(23, 36).

The sustained improvement observed across different levels of student experience suggests that reflection, when effectively integrated with feedback, enhances deliberate practice even in more experienced trainees. The study emphasized that reflection, when scaffolded with timely feedback, promotes metacognitive engagement and sustained skill acquisition in real-world clinical settings, supporting its inclusion in competency-based curricula for learners at all stages of training(26).

This study advances the current understanding by implementing a real-time feedback reflection model, distinguishing it from prior research that examined post-hoc or delayed reflection(37). By coupling immediate performance feedback with structured reflection, our approach facilitated direct cognitive and emotional engagement with learning experiences, which is consistent with emerging evidence on the importance of feedback timing in skill acquisition(38).

Furthermore, the use of the Atkins model provided a scaffolded framework for reflection, ensuring systematic progression from descriptive analysis to actionable insights and methodological strength over less structured approaches in earlier studies(23, 39). These findings have important implications for medical education. First, reflection training should be intentionally sequenced before hands-on skill sessions, particularly for complex procedural tasks. Second, faculty development must emphasize not only the delivery of constructive feedback but also strategies to guide learners in reflective processing.

The strong positive correlation observed between reflective ability and practical skill performance provides compelling evidence that metacognitive engagement with feedback enhances technical skill acquisition. While the mean reflective score of 3.73/6 (62.2% of the maximum) suggests room for growth in trainees' reflective ability, the near-perfect correlation indicates that even developing reflective skills substantially benefits procedural competence. This finding aligns with theoretical frameworks suggesting that reflection transforms surface-level performance into deep learning by promoting the cognitive integration of feedback, deliberate practice, and self-regulated improvement strategies(40).

The magnitude of this correlation exceeds those reported in similar studies of reflection in clinical education, potentially due to our structured Atkins model approach, which systematically guided learners through description, analysis, and actionable planning phases. This methodological rigor may have optimized the quality of reflection compared with more open-ended approaches. Notably, the relationship persisted across all skill levels, suggesting that reflection benefits both novice and experienced learners, a finding that is consistent with Ericsson's deliberate practice theory(41) but extends it by quantifying how metacognitive processes amplify skill development.

The findings of this study suggest that developing reflective thinking skills requires ongoing practice and longitudinal engagement, which may not be fully achieved through short-term interventions. Learners in this study would likely benefit from more opportunities to repeatedly engage in reflective exercises in future implementations. This indicates a need for the design of educational programs that integrate reflection as a continuous component rather than a one-time workshop, in line with prior literature emphasizing the iterative nature of reflection(24, 42)

This perspective is reinforced by a recent scoping review, which demonstrated that structured, group-based reflection facilitated by trained educators and grounded in shared clinical narratives enhances both reflective ability and the formation of professional identity among medical students(43).

Conclusion

This study demonstrates that structured reflection on feedback meaningfully enhances the development of both the technical skills and reflective ability of medical trainees. Compared with those who received conventional training alone, those who engaged in guided reflection showed markedly better practical performance. The strong correlation between reflective ability and technical competence underscores reflection's vital role in translating feedback into improved practice. These benefits were consistently observed across different learner characteristics, confirming the universal relevance of reflection in clinical education. The findings strongly support incorporating formal reflection training into procedural skills curricula. Key recommendations include implementing structured reflective frameworks, facilitating immediate reflection during hands-on learning, and equipping educators to effectively guide this process. While the current results highlight significant short-term improvements, further investigations should explore the longitudinal impact of reflective practice on skill retention and progressive mastery.

Importantly, the impact of reflective practice may vary depending on the fidelity of the simulation environment, instructor engagement, and student motivation. Future research should explore how these contextual factors influence the effectiveness of structured reflection across diverse clinical procedures and learner populations.

Limitations and future directions

This study faced three primary limitations. First, there was a potential risk of content leakage between groups, as students in the intervention and control groups were enrolled in the same educational setting. Given the nature of reflective practice, which requires instructor-guided engagement, repeated practice, and individualized feedback, mere exposure to the reflection guide or peer discussion was unlikely to result in meaningful skill transfer. Nonetheless, the research team took proactive steps to minimize this risk by explicitly asking participants in the intervention group not to share workshop content with peers in the control group.

Second, the risk of incomplete participation in the workshops and inconsistent submission of reflective reports posed a potential threat to the integrity of the intervention. To address this, the research team emphasized the educational value of both reflective practice and suturing workshops, clarified the importance of student involvement in the success of the study, and encouraged active engagement by framing participation as a collaborative contribution to the thesis project. These measures appeared effective in maintaining a satisfactory level of participation and compliance.

The third is the absence of baseline RAR and procedural skill data; given the quasi-experimental design and nonrandomized allocation, baseline assessment was not feasible within the instructional setting. However, comparable demographic characteristics and prior training exposure across groups partly mitigate this concern.

Future research may consider implementing cluster randomization or scheduling interventions across different academic terms to eliminate contamination risk. Additionally, integrating reflective skills

training into formal curricula may enhance engagement and ensure broader implementation across educational contexts.

Abbreviations

RAR
Reflective Ability Rubric
SPSS
Statistical Package for the Social Sciences

Declarations

Ethical considerations

The Ethics Committee of Kashan University of Medical Sciences granted the study's ethical approval under the code IR.KAUMS.MEDNT.REC.1401.027, and written informed consent was obtained from all participants. The confidentiality of the data was strictly maintained, and the participants were free to withdraw at any time without academic repercussions. Importantly, all participants were offered access to reflection training after the study, demonstrating our commitment to their ongoing professional development and ensuring equitable educational opportunities.

Consent for Publication

All experts participating in this study provided verbal informed consent for the publication of the study results without the disclosure of individual names. The process of obtaining verbal informed consent was approved by the Ethics Committee of Kashan University of Medical Sciences. The results have been presented in an aggregated form without mentioning individual names.

Availability of Data and Material

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request. Data sharing complies with the ethical standards of Kashan University of Medical Sciences.

Competing Interests

The authors declare no conflict of interest.

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Author Contributions

M.N., F.M., M.A., S.G.M. and S.A.S. made significant contributions to the conceptualization and study design, as well as data acquisition, and writing and revising the manuscript. F.M., M.A., J.S. and S.A.S. writing and critically revised the manuscript for important intellectual content and finalized the manuscript. All the authors approved the final version of the manuscript.

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References

1. Branch WT Jr., Paranjape A. Feedback and reflection: teaching methods for clinical settings. Acad Med. 2002;77(12 Pt 1):1185–8.
2. Yousefy A. Competency-Based Education (CBE). Iran J Med Educ. 2005;5(2):200–1.
3. Nguyen QD, Fernandez N, Karsenti T, Charlin B. What is reflection? A conceptual analysis of major definitions and a proposal of a five-component model. Med Educ. 2014;48(12):1176–89.
4. Sandars J. The use of reflection in medical education: AMEE Guide 44. Med Teach. 2009;31(8):685–95.
5. Mann K, Gordon J, MacLeod A. Reflection and reflective practice in health professions education: a systematic review. Adv Health Sci Educ Theory Pract. 2009;14(4):595–621.
6. Ingham-Broomfield B. A nurses' guide to using models of reflection. Australian J Adv Nurs. 2021;38(4):62–7.
7. Pee B, Woodman T, Fry H, Davenport ES. Practice-based learning: views on the development of a reflective learning tool. Med Educ. 2000;34(9):754–61.
8. Shute VJ. Focus on formative feedback. Rev Educ Res. 2008;78(1):153–89.
9. Moattari M, Abedi H. Nursing students' experiences in reflective thinking: A qualitative study. Iran J Med Educ. 2008;8(1):101–12.
10. Robotham D. The application of learning style theory in higher education teaching.[cited 2010 Aug 25]. Avilable from: www glos ac uk/gdn/discuss. 2003.
11. Ekelin M, Kvist LJ, Persson EK. Midwifery competence: Content in midwifery students' daily written reflections on clinical practice. Midwifery. 2016;32:7–13.
12. Persson EK, Kvist LJ, Ekelin M. Analysis of midwifery students' written reflections to evaluate progression in learning during clinical practice at birthing units. Nurse Educ Pract. 2015;15(2):134–40.

13. Grant AJ, Vermunt JD, Kinnersley P, Houston H. Exploring students' perceptions on the use of significant event analysis, as part of a portfolio assessment process in general practice, as a tool for learning how to use reflection in learning. BMC Med Educ. 2007;7(1):1–8.
14. Hunt E, Bigdeli S, Mirhosseini F. A Practical Guide for Medical Teachers – 6th Edition -Elsevier Chapter 41- The teacher as a scholar. 2021.
15. Ménard L, Ratnapalan S. Teaching moment: reflection in medicine: models and application. Can Fam Physician. 2013;59(1):105–e59.
16. Aronson L. Twelve tips for teaching reflection at all levels of medical education. Med Teach. 2011;33(3):200–5.
17. Wald HS, Davis SW, Reis SP, Monroe AD, Borkan JM. Reflecting on reflections: enhancement of medical education curriculum with structured field notes and guided feedback. Acad Med. 2009;84(7):830–7.
18. Quinton S, Smallbone T. Feeding forward: using feedback to promote student reflection and learning–a teaching model. Innovations Educ Teach Int. 2010;47(1):125–35.
19. Driessen EW, van Tartwijk J, Overeem K, Vermunt JD, van der Vleuten CP. Conditions for successful reflective use of portfolios in undergraduate medical education. Med Educ. 2005;39(12):1230–5.
20. Reflection in Medical Education. J Univ Teach Learn Pract. 2016;13(2).
21. Sobral DT. Medical students' reflection in learning in relation to approaches to study and academic achievement. Med Teach. 2001;23(5):508–13.
22. de la Croix A, Veen M. The reflective zombie: Problematizing the conceptual framework of reflection in medical education. Perspect Med Educ. 2018;7(6):394–400.
23. McGlinn EP, Chung KC. A pause for reflection: incorporating reflection into surgical training. Ann Plast Surg. 2014;73(2):117–20.
24. Tawanwongsri W, Phenwan T. Reflective and feedback performances on Thai medical students' patient history- taking skills. BMC Med Educ. 2019;19.
25. Khanum Z. Effectiveness of reflective exercises for obstetrics and gynaecological residents. J Coll Physicians Surg Pak. 2013;23(7):468–71.
26. Maqsood Z, Sajjad M, Yasmin R. Effect of feedback-integrated reflection, on deep learning of undergraduate medical students in a clinical setting. BMC Med Educ. 2025;25(1):66.
27. Pallansch R, Gaiser RR. A Departmentally Developed Agreement to Improve Faculty-Resident Feedback. J Educ Perioper Med. 2023;25(1):E697.
28. Hoffman LA, Shew RL, Vu TR, Brokaw JJ, Frankel RM. Is Reflective Ability Associated With Professionalism Lapses During Medical School? Acad Med. 2016;91(6):853–7.
29. Guni A, Raison N, Challacombe B, Khan S, Dasgupta P, Ahmed K. Development of a technical checklist for the assessment of suturing in robotic surgery. Surg Endosc. 2018;32(11):4402–7.
30. Brunicardi FCAD, Billiar TR, Dunn DL, Hunter JG, Matthews JB, Pollock RE. Suturing technique. In: Brunicardi FC ea, editor. Schwartz’s Principles of Surgery. 11th ed. New York: McGraw-Hill Education;

2010.
31. Epner DE, Baile WF. Difficult conversations: teaching medical oncology trainees communication skills one hour at a time. Acad Med. 2014;89(4):578–84.
32. Ganni S, Botden SMBI, Schaap DP, Verhoeven BH, Goossens RHM, Jakimowicz JJ. Reflection-Before-Practice Improves Self-Assessment and End-Performance in Laparoscopic Surgical Skills Training. J Surg Educ. 2018;75(2):527–33.
33. Hillemans V, Buyne O, de Blaauw I, Botden S, Verhoeven BH, Joosten M. Self-assessment, and not continuous training, improves basic open suturing skills. Med Educ Online. 2024;29(1):2374101.
34. Fatima T, Khan RA, Azhar F, Mahboob U. Thoughtful surgical practice for therapeutic self: A randomized control trial. Pak J Med Sci. 2020;36(7):1466–70.
35. Abraham R, Singaram VS. Self and peer feedback engagement and receptivity among medical students with varied academic performance in the clinical skills laboratory. BMC Med Educ. 2024;24(1):1065.
36. Mlinar Reljić N, Pajnkihar M, Fekonja Z. Self-reflection during first clinical practice: The experiences of nursing students. Nurse Educ Today. 2019;72:61–6.
37. Makrides A, Yeates P. Memory, credibility and insight: How video-based feedback promotes deeper reflection and learning in objective structured clinical exams. Med Teach. 2022;44(6):664–71.
38. Liu A, Duffy M, Tse S, Zucker M, McMillan H, Weldon P, et al. Concurrent versus terminal feedback: The effect of feedback delivery on lumbar puncture skills in simulation training. Med Teach. 2023;45(8):906–12.
39. Wald HS, Borkan JM, Taylor JS, Anthony D, Reis SP. Fostering and evaluating reflective capacity in medical education: developing the REFLECT rubric for assessing reflective writing. Acad Med. 2012;87(1):41–50.
40. Gayathri B, Vedavyas R, Sharanya P, Karthik K. Effectiveness of reflective learning in skill-based teaching among postgraduate anesthesia students: An outcome-based study using video annotation tool. Med J Armed Forces India. 2021;77:S202–7.
41. Ericsson KA, Krampe RT, Tesch-Römer C. The role of deliberate practice in the acquisition of expert performance. Psychol Rev. 1993;100(3):363.
42. Rahman NFA, Albualy R. A Comparative Analysis of Reflection in a primary Care Outpatient Setting in Two Learning Environments. Educ Med J. 2018.
43. Phua GLG, Owyong JLJ, Leong ITY, Goh S, Somasundaram N, Poon EYL, et al. A systematic scoping review of group reflection in medical education. BMC Med Educ. 2024;24(1):398.

Figures

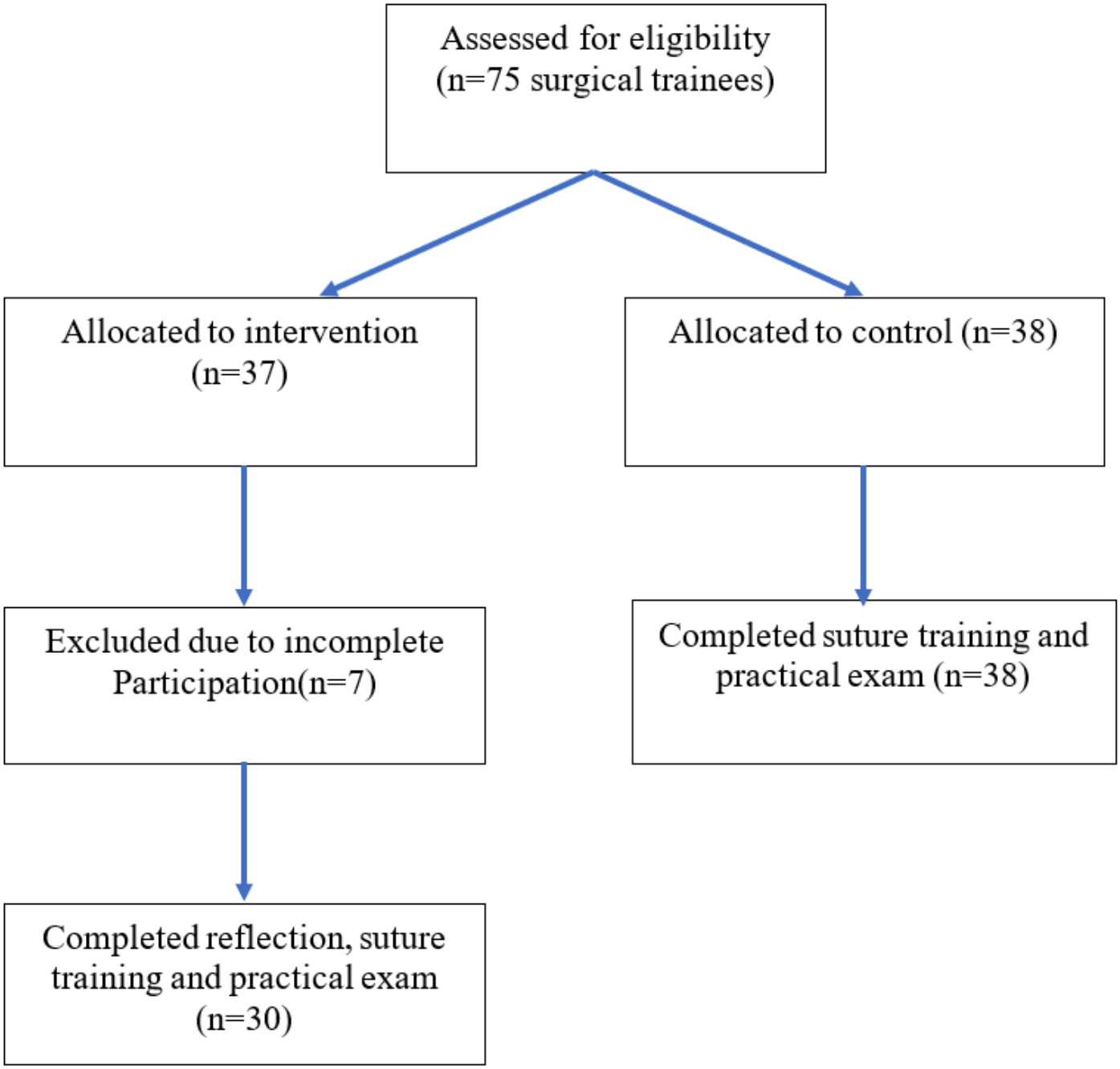


Figure 1

Flowchart of participant allocation and completion status in the study. A total of 75 participants were assessed for eligibility and nonrandomly assigned to either the intervention group (n = 37) or the control group (n = 38). The intervention group underwent reflection training before the suture workshop, whereas the control group participated in suture training without prior reflection. Seven participants from the intervention group were excluded because of incomplete data.

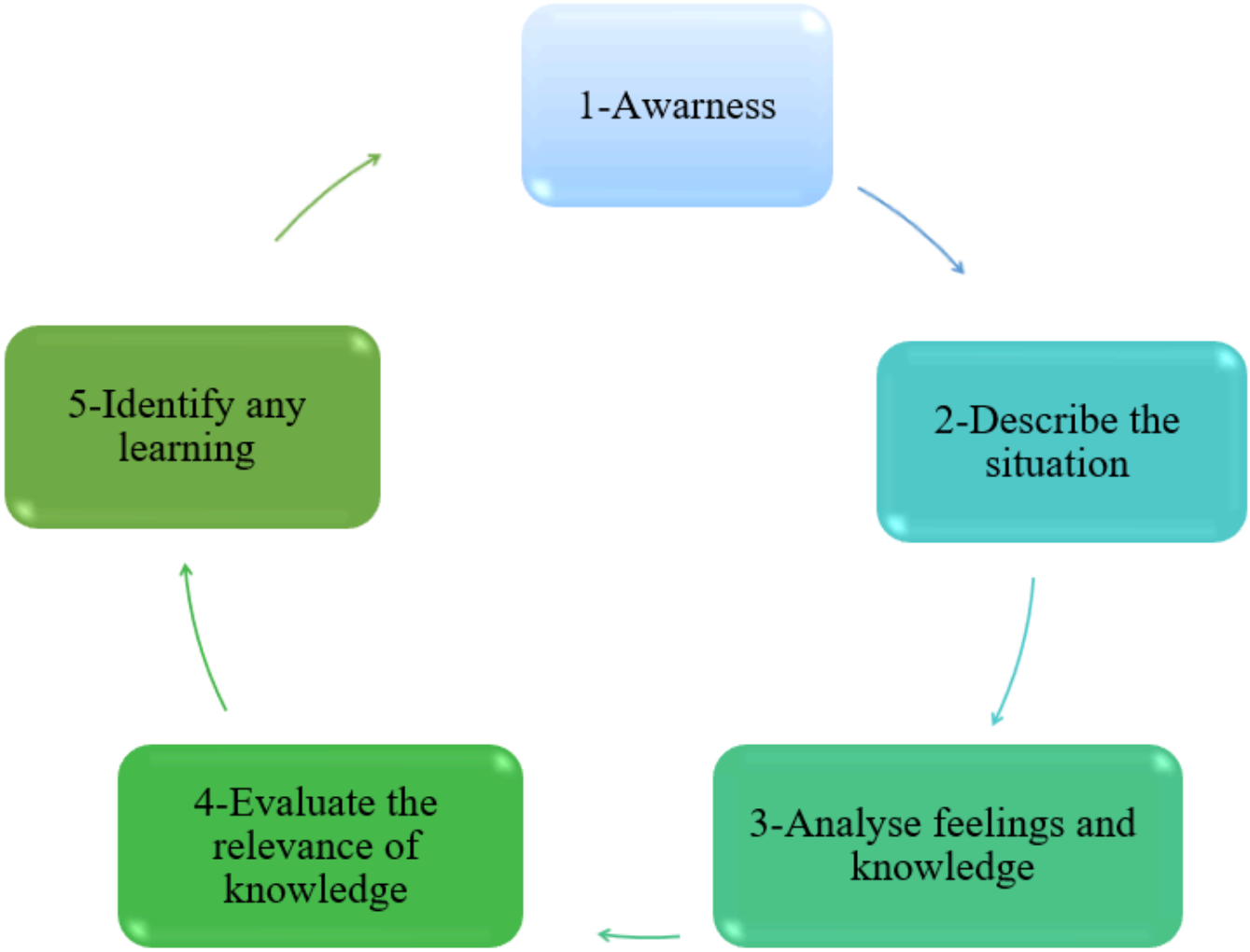


Figure 2

Atkins model of reflection