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Effectiveness of deliberate practices versus conventional lecture in trauma training for medical students

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Abstract

Background A mastery of life-threatening trauma procedures is important for medical students aiming to become proficient physicians. Thus, this study compares the effectiveness of deliberate practice with that of conventional lecture methods in teaching such students these essential skills.

Methods A randomized controlled trial was conducted with 48 first- to third-year medical students at the Faculty of Medicine Vajira Hospital at Navamindradhiraj University (Thailand). The participants were randomly assigned to either the deliberate practice group ($n=24$) or the conventional lecture group ($n=24$). The primary outcome was the students' scores on the Objective Structured Clinical Examination (OSCE), whereas the secondary outcome was their overall grades. Moreover, analysis of covariance (ANCOVA) was used to control for the impacts of gender and academic year.

Results The deliberate practice group had significantly higher OSCE scores (mean = 69.79, SD = 9.49) than did the conventional lecture group (mean = 51.38, SD = 14.59), with a p value of 0.000002. Additionally, the deliberate practice group had no clear failures or seven good passes, whereas the conventional lecture group had five clear failures and no good passes. Moreover, the ANCOVA results indicated that the type of training had a significant positive effect on the students' examination scores, independent of gender and academic year ($F(4, 43) = 7.44$, $p = 0.0001$).

Conclusion Deliberate practice is significantly more effective than the conventional lecture method in teaching life-threatening trauma procedures to medical students. The implication of these findings is that implementing deliberate practice in medical education can enhance the competencies of students, improve their preparedness for real-world clinical settings, and produce better patient outcomes. However, future research should examine the broader applications and long-term benefits of this method in medical training.

Trial registration TCTR20240816009

Keywords Deliberate practice, Medical student, Trauma training

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Background

The Advanced Trauma Life Support (ATLS) program is one of the cornerstones of medical education that provides medical students with the necessary skills to manage life-threatening trauma effectively. On the basis of the need for accurate and prompt diagnosis, the principles of ATLS follow a precise sequence of interventions (A, B, C, D, E) to address critical threats to life. This structured approach ensures that medical professionals provide both comprehensive and efficient care to trauma patients, significantly impacting patient outcomes [1].

Given the importance of trauma management, effective teaching of ATLS is paramount. In this context, medical students must not only understand the theoretical aspects of these procedures but also be proficient enough to perform them under pressure. Moreover, traditional teaching methods generally involve a combination of didactic lectures and hands-on practice sessions. Despite these activities, some students still have difficulty obtaining the necessary competency in trauma procedures, indicating a gap in current educational approaches.

However, a promising educational strategy is deliberate practice, which has been shown to improve learning and performance in various health-related fields, including medicine. Specifically, deliberate practice involves focused and repetitive practice of specific skills for the purpose of continuous improvement. The main components of this method include establishing clear objectives, receiving immediate and constructive feedback, and engaging in targeted practice over time. This is in contrast to more traditional teaching methods, which may not necessarily provide the same level of targeted/immediate feedback and iterative learning opportunities [2].

The hypothesis driving this study is that deliberate practice will improve the competency of medical students in ATLS procedures more effectively than the conventional teaching method. In addition, by incorporating deliberate practice into the curriculum, such students gain a deeper understanding and greater proficiency in performing these life-saving interventions. This approach aims not only to improve technical skills but also to foster a more intuitive and confident response during medical emergencies.

Therefore, this study compares the effectiveness of deliberate practices with that of conventional lecture methods in a controlled educational setting. The primary objective is to evaluate the improvement in the students' scores on the Objective Structured Clinical Examination (OSCE), whereas the secondary objective is to assess the students' confidence and preparedness in handling trauma cases both professionally and efficiently.

Materials and methods

Study design and population

This study conducted a randomized controlled trial to compare the effectiveness of deliberate practice and conventional lecture methods in teaching life-threatening trauma procedures to medical students. The target population comprised students who had yet to gain experience/training in managing life-threatening trauma. Specifically, the sample population included first- to third-year medical students in the Faculty of Medicine Vajira Hospital at Navamindradhiraj University (Thailand). Ethical approval for the study was obtained from the Ethical Review Board of the Faculty of Medicine Vajira Hospital. All the participants provided written informed consent before enrollment.

Sample size

The sample size was based on preliminary data from comprehensive examinations in the 2023 academic year, in which the average score of failing students was 27 ± 6.81. Using these data, it was determined that a sample size of 48 students would be sufficient for this research. The participants were then randomly assigned to one of the two groups.

This study was conducted as an extracurricular program in which first- to third-year medical students were invited to participate voluntarily. This program was distinct from the standard curriculum, as the formal teaching of this subject is typically provided to fifth- and sixth-year students. Participation was entirely optional, with no influence on grades or regular academic progression. Additionally, upon completion of the research, the research team conducted a comprehensive session for both groups to ensure that all participants gained an equivalent understanding of the subject matter, reinforcing fairness and knowledge dissemination.

Randomization

Randomization was conducted using a computer-generated list with stratification by academic year to ensure balanced group distribution. A block randomization method (blocks of two) minimized selection bias. The allocation sequence was concealed in sealed envelopes prepared by an independent coordinator and opened only at group assignment. This process ensured transparency and fairness.

Structure of training sessions

"Both the deliberate practice group and the conventional group received a total of three hours of training. However, the structure of the training sessions varied between the groups. The conventional group completed the training in a single 3-hour continuous block, where

all theoretical content was delivered sequentially through PowerPoint presentations, followed by a single practical session covering the entire procedure. The deliberate practice group, on the other hand, underwent three separate 1-hour sessions over three consecutive days. Each session targeted a specific step of the procedure, incorporating hands-on practice with immediate feedback and readiness assessments at the end of each session. This staggered structure enabled participants to consolidate their learning, refine their skills, and progressively build on their knowledge, aligning with the principles of deliberate practice."

Deliberate practice training sessions

The deliberate practice training sessions were conducted on standardized models simulating real-life trauma scenarios. Each participant received a total of three hours of training, divided into three separate one-hour sessions conducted over three consecutive days. Students were organized into small groups of 4–6 participants to allow for effective supervision and individualized feedback. Each session focused on specific trauma procedures, enabling students to practice step-by-step techniques on the models. Performance was evaluated using a structured checklist assessing accuracy, safety, and procedural steps. Immediate feedback was provided by instructors after each practice session, and students' readiness to proceed to the next topic was assessed at the end of each session. If any student required additional practice to meet competency standards, tailored guidance and additional opportunities were provided to ensure all participants were prepared to advance to the next stage of training.

Teaching tools

Both groups applied the same teaching tools, including PowerPoint presentations, practical equipment (e.g., trauma models), and examination materials.

- In the conventional group, a single 3-h session included sequential theoretical content followed by practical training. Feedback was provided collectively at the end of the session.
- In the deliberate practice group, the content was divided into three 1-h sessions over three days, with each session focusing on specific steps, immediate feedback, and readiness assessments to ensure mastery before progressing.

Pretest and posttest

Pretest

Before the training began, all students participated in a pretest designed to assess their baseline theoretical knowledge of trauma management. The pretest consisted of a multiple-choice questionnaire (MCQ) delivered through Google Forms. The questions were case-based, focusing on the management of patients with life-threatening conditions and emphasizing critical decision-making skills.

Posttest

After completing the training, students were evaluated through an Objective Structured Clinical Examination (OSCE) to assess their practical skills. The OSCE was designed to evaluate students' ability to manage life-threatening trauma cases following the ATLS primary survey framework. It comprised five stations focusing on airway management, breathing, circulation, disability, and exposure, with tasks and scenarios reflecting real-life trauma situations. Each station was scored using a standardized checklist with criteria for accuracy, safety, efficiency, communication, and adaptability.

The practical examination was further standardized and evaluated using a predefined checklist that included knowledge of managing life-threatening trauma during the initial assessment and management phases. Each component of the practical examination was evaluated based on performance categorized as "performed well," "partially performed," or "not performed." Additionally, an overall grade was assigned to each participant, reflecting their competency in managing life-threatening trauma cases. The passing level for the examination was set at 65%, ensuring that students demonstrated sufficient proficiency to handle critical procedures effectively.

Statistical analysis

To maintain confidentiality, data collection was performed anonymously using a coded system. Research assistants, who were blinded to group assignments, collected and entered the data into an Excel spreadsheet. Statistical analysis was conducted using Analysis of Covariance (ANCOVA) to compare post-test performance between the conventional teaching group and the deliberate practice group. Pretest scores were included as a covariate to control for baseline differences in knowledge and skills, while additional covariates, such as academic year, were incorporated to account for potential confounding factors. This approach ensured that observed differences in post-test performance were adjusted for variability in baseline measures, providing a clearer understanding of the impact of the teaching methods.

Categorical data were presented as frequencies and percentages and analyzed using the chi-square test or Fisher's exact test. Continuous data were presented as means and standard deviations (or medians and

interquartile ranges) and analyzed using independent t-tests or quartile regression. The primary outcome, students' scores on the OSCE, was analyzed via ANCOVA, adjusted for academic year and gender, and is presented as means and standard deviations. Results are reported with 95% confidence intervals, and statistical significance was set at $p < 0.05$.

Results

According to the baseline characteristics of the 48 participants in Table 1, the mean age of the participants was 19.52 years (SD = 0.62), with Group 1 having a mean age of 19.50 years (SD = 0.72) and Group 2 having a mean age of 19.54 years (SD = 0.51). The median age was consistent across both groups at 19.50 years, with a range of 19.00–20.00 years. The frequency of male participants was 60.42% overall, with Group 1 including 62.50% males and Group 2 including 58.33% males. With respect to their academic year distribution, 14 participants were in their first year, 18 were in their second year, and 16 were in their third year, with both groups having similar distributions across academic years.

On the basis of the OSCE scores and overall grades in Table 2, the mean OSCE score for Group 1 was 51.38 (SD = 14.59), whereas Group 2 had a significantly higher mean score of 69.79 (SD = 9.49). In this case, the p value was 0.000002, indicating a statistically significant difference. In terms of overall grades, Group 1 had five participants who had no clear failures, six who failed, two who were fair, 10 who passed, and none who achieved a good pass. Conversely, Group 2 had no clear failures, two who failed, none who were fair, 16 who passed, and seven who achieved a good pass. The p value for the overall grade was 0.00001, indicating statistically significant differences between the groups.

Moreover, the ANCOVA, which controlled for the impacts of academic year and gender, revealed significant differences in the examination scores between the groups. In this case, the adjusted R-squared value was 0.3541, indicating that 35.41% of the variance in the examination scores was explained by the model. Additionally, the F statistic was 7.44, with a p value of 0.0001, indicating that the overall model was significant. Specifically, being in Group 2 was associated with a significantly higher examination score (coef. = 18.45221, $p = 0.0000$), whereas the effects of gender (coef. = −2.390069, $p = 0.512$) and academic year (second year: coef. = 8.878014, $p = 0.117$; third year: coef. = 2.859741, $p = 0.537$) were not statistically significant.

Table 2 OSCE scores and overall grades

Score	Group 1 ($n = 24$)	Group 2 ($n = 24$)	p-value
OSCE score	51.38 ± 14.59	69.79 ± 9.49	0.000002
Overall grade			
• Clear fail	5	0	0.00001
• Fail	6	2	0.00001
• Fair	2	0	0.00001
• Pass	10	16	0.00001
• Good pass	0	7	0.00001

The results of the self-assessment survey revealed that the deliberate practice group reported significantly higher confidence and preparedness compared to the conventional group. The mean confidence score for the deliberate practice group was 4.6 ± 0.5, compared to 3.4 ± 0.8 for the conventional group ($p < 0.01$). Similarly, the mean preparedness score was 4.5 ± 0.6 in the deliberate practice group versus 3.3 ± 0.7 in the conventional group ($p < 0.01$). These findings underscore the added benefit of deliberate practice in enhancing not only technical skills but also students' self-efficacy and readiness for clinical practice.

In summary, Group 2, which received deliberate practice training, had significantly higher OSCE scores and better overall grades than did Group 1. The ANCOVA results also confirmed that the type of training (Group 2) had a significant positive effect on the examination

Table 1 Baseline characteristics

Characteristic	Overall	Group 1	Group 2
Age (year)			
- Mean ± SD	19.52 ± 0.62	19.50 ± 0.72	19.54 ± 0.51
- Median (min–max)	19.50 (19.00–20.00)	19.00 (19.00–20.00)	19.50 (19.00–20.00)
Sex (frequency, % male)	29 (60.42%)	15 (62.50%)	14 (58.33%)
Academic year			
- 1st	14	8	6
- 2nd	18	8	10
- 3rd	16	8	8

scores, independent of the participants' gender and academic year.

Discussion

On the basis of the results of this study, deliberate practice was significantly more effective than the conventional lecture method in teaching medical students about life-threatening trauma procedures. In this case, the students trained through deliberate practice scored significantly higher on the OSCE and had better overall grades than those under the conventional lecture method did. For example, the mean OSCE score for the deliberate practice group (Group 2) was 69.79, whereas it was 51.38 for the conventional group (Group 1), with a highly significant p value of 0.000002. Moreover, Group 2 had no clear fails and seven good passes, whereas Group 1 had five clear fails and no good passes. These findings highlight not only the efficacy of deliberate practice in improving both the understanding and performance of medical students in critical trauma procedures but also its value in high-stakes and skill-intensive domains such as trauma care.

It is important to note that while both groups received an equal total training duration of 3 h, the deliberate practice group benefited from a distributed learning schedule. This structure provided additional opportunities for iterative feedback, reflection, and readiness assessments, which likely contributed to improved retention and skill acquisition. Educational research consistently supports the notion that spaced learning enhances long-term outcomes compared to massed learning. This staggered approach may have played a significant role in the deliberate practice group's superior performance. Future studies should explore whether the distribution of training time itself, independent of the teaching method, has an impact on learning effectiveness and skill acquisition.

Overall, this study provides strong evidence for the application of deliberate practice in medical education, especially for teaching life-threatening trauma procedures to medical students. As stated earlier, deliberate practice, as proposed by Ericsson et al. [2] is characterized by focused, goal-oriented, and repetitive practice with immediate feedback, enabling individuals to develop expertise in a specific domain. In this study, the superior performance of the students in Group 2 indicated that structured, purposeful practice effectively increased their skill acquisition. The findings of this study also align with those of Wayne et al. [3] who showed that simulation-based training that incorporated deliberate practice significantly improved the skills of medical residents in advanced cardiac life support (a similar critical procedure). Additionally, Tantiphlachiva et al. [4] demonstrated that deliberate practice greatly enhanced the clinical skills and competencies of medical students, further supporting our findings. While deliberate practice has demonstrated effectiveness, it should be noted that it complements rather than replaces traditional instruction methods. For example, conventional lecture-based education is extremely efficient at providing foundational knowledge and is widely used in medical education to introduce core concepts [5, 6]. In this case, lectures allow instructors to present a broad overview of important topics, offer explanations of complex theories, and clarify students' questions in real time. When used with deliberate practice, lecture-based instruction can be effective for building an initial understanding before students become engaged in hands-on practice. This is in line with the findings of Issenberg et al. [7] who noted that various instructional methods (e.g., technology-enhanced learning methods) in combination with deliberate practice can be effective for learning in medical education.

The use of ANCOVA in this study was critical in adjusting for potential confounders, such as baseline pretest scores and group characteristics, enhancing the reliability and validity of the findings. By accounting for these variables, ANCOVA allowed for a more accurate comparison of post-test performance between groups, ensuring that the observed differences were primarily attributable to the teaching methods. This statistical adjustment strengthens the study's conclusions and underscores the effectiveness of deliberate practice in improving learning outcomes. Future studies should continue to use robust statistical methods, such as ANCOVA, to minimize bias and provide more reliable comparisons in educational research.

In this context, Cook et al. [8] indicated that the use of virtual simulations paired with deliberate practice principles can lead to effective learning outcomes that are comparable to those of traditional clinical education. Such simulations can provide a controlled environment in which students are introduced to scenarios before progressing to more intensive, real-world clinical contexts [9, 10]. For example, during trauma procedure training, students in deliberate practice sessions can concentrate on critical components such as airway management, hemorrhage control, and rapid patient assessment. The feedback provided during these sessions can help them identify areas for improvement and refine their techniques [11]. According to McGaghie et al. [12] deliberate practice in simulation-based education has been shown to increase clinical competency and skills retention over time.

The observed improvement in confidence and preparedness among the deliberate practice group is consistent with the principles of deliberate practice, which

emphasize iterative feedback, skill refinement, and stepwise mastery. These findings suggest that deliberate practice offers more than just procedural competence—it enhances self-efficacy and readiness to manage high-pressure clinical situations. Confidence and preparedness are critical factors in clinical performance, and the deliberate practice model appears to address these aspects effectively. Future studies could explore the long-term impact of enhanced self-efficacy on clinical decision-making and patient outcomes.

In this study, the deliberate practice sessions also allowed the students to break down complex trauma procedures into smaller, more manageable components, fostering targeted practice and refinement of specific clinical skills [13]. Meanwhile, immediate feedback during these sessions (either from expert facilitators or through self-assessment) enabled the students to pinpoint areas for improvement and adjust their techniques accordingly [14]. This iterative process of targeted practice and feedback allowed the students to continuously challenge themselves and improve their performance. The goal-oriented nature of deliberate practice also helps them maintain their motivation and engagement, which are essential for long-term skills development [2, 11, 15].

Overall, this study's strengths include its randomized controlled design, which minimized biases and enhanced the reliability of the results, and the use of the OSCE for assessing competency, which provided a robust measure of medical students' skills. Moreover, controlling for covariates, such as gender and academic year, through ANCOVA strengthened the validity of the findings.

However, several limitations should be noted. First, the study was conducted within a single medical school, which may limit the generalizability of the findings to other institutions with different educational settings or student populations. Second, the sample size, while adequate for detecting significant differences, was relatively small, and the diversity of participants was limited, which may have further constrained the applicability of the results. Third, the short-term focus of this study did not allow for an assessment of long-term skill retention or the impact of deliberate practice on clinical performance in real-world settings.

Future research should replicate these results in various medical schools with larger, more diverse sample sizes to confirm their generalizability. Longitudinal studies are also needed to evaluate the long-term retention of skills acquired through deliberate practice and their effectiveness in clinical practice. Furthermore, investigating the use of deliberate practice in other areas of medical education can provide a broader understanding of its benefits and limitations. Identifying the specific components of deliberate practice that contribute the most to skill acquisition can also help refine and optimize training programs for medical students on a wider scale.In summary, while deliberate practice has proven to be a powerful tool in developing expertise in medical students, it works best in conjunction with other methods that provide foundational knowledge and situational context. Although this study adds to the literature supporting the use of deliberate practice in medical education, further research is necessary to determine how to best integrate this method with other instructional techniques to optimize learning outcomes in various educational contexts.

Conclusion

This study provides evidence that deliberate practice is an effective teaching method for life-threatening trauma procedures in medical education. The findings demonstrated that medical students trained using deliberate practice achieved significantly higher OSCE scores and better overall grades than those taught through conventional lecture methods. Deliberate practice, with its emphasis on repeated practice, clear objectives, and continuous feedback, improves skill acquisition in trauma procedures.

However, these findings should be interpreted within the context of the study's limitations, including its single-institution setting and relatively small sample size. While deliberate practice shows promise as a valuable addition to medical training programs, it should be considered complementary to traditional teaching methods, which provide foundational knowledge. Future research should explore broader applications of deliberate practice across different medical disciplines and assess its long-term impact on skill retention and clinical performance.

Abbreviations

ANCOVA	Analysis of covariance
OSCE	Objective Structured Clinical Examination
ATLS	The Advanced Trauma Life Support

Supplementary Information

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Supplementary Material 1.

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Ethics declarations

This research project was approved by the Vajira Institutional Review Board, Faculty of Medicine, Vajira Hospital, Navamindradhiraj University. This study was conducted in accordance with relevant guidelines such as the

Declaration of Helsinki. Informed consent was obtained from all participants who took part in this study.

Authors' contributions
S.K. and S.T. conceptualized and designed the study. S.K., A.T., B.N., I.L., P.S., and S.T. collected the data. S.K. and S.T. analyzed the data and drafted the manuscript. All authors critically reviewed and approved the final manuscript and agree to be personally accountable for their contributions to the study, ensuring the integrity and accuracy of its content.

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Data availability
The deidentified transcription data used in this study are available from the corresponding author upon reasonable request. Access will be granted to researchers for academic purposes, subject to ethical approval and compliance with data sharing policies.

Declarations

Ethics approval and consent to participate
This research project was approved by the Vajira Institutional Review Board, Faculty of Medicine, Vajira Hospital, Navamindradhiraj University. This study was conducted in accordance with relevant guidelines such as the Declaration of Helsinki. Informed consent was obtained from all participants who took part in this study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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