Mastery Learning in an Intestinal Ultrasound Workshop for Inflammatory Bowel Disease: Evaluating Its Effectiveness in Enhancing Skill Acquisition

Rabbinu Rangga Pribadi[1]*, Raisa Wibowo[1], Virly Nanda Muzellina[1], Nikko Darnindro[2], Ahmad Fariz Malvi Zamzam Zein[2], Achmad Fauzi[1], Marcellus Simadibrata[1]

[1]Division of Gastroenterology, Pancreatobiliary and Digestive Endoscopy, Department of Internal Medicine, Faculty of Medicine Universitas Indonesia - Cipto Mangunkusumo Hospital, Jakarta, Indonesia.
[2]Division of Gastroenterohepatology, Department of Internal Medicine, Fatmawati General Hospital, Jakarta, Indonesia.

Corresponding author:
Rabbinu Rangga Pribadi, MD. Division of Gastroenterology, Pancreatobiliary and Digestive Endoscopy, Department of Internal Medicine, Faculty of Medicine Universitas Indonesia - Cipto Mangunkusumo Hospital. Jl. Diponegoro No. 71, Jakarta 10430, Indonesia. Email: rabbinurangga@gmail.com.

ABSTRACT

Background: *Intestinal ultrasound (IUS) is a non-invasive tool for monitoring inflammatory bowel disease (IBD), offering high diagnostic accuracy and greater patient convenience than gastrointestinal endoscopy. The present study evaluated the feasibility of a mastery learning approach in Indonesia's inaugural IUS workshop to enhance skill acquisition among physicians.* ***Methods:*** *A retrospective study was conducted on 37 physicians who participated in a two-day IUS workshop employing a mastery learning approach that included flipped learning, lectures, a pre-test, hands-on sessions with real-time feedback, and a post-test. Skill acquisition was assessed using standardized checklists for scanning the sigmoid colon and terminal ileum, with pre- and post-test performance evaluated against a minimum passing standard (MPS) established by expert faculties. Data was analyzed using SPSS with appropriate statistical tests to determine learning outcomes and effect sizes.* ***Results:*** *34 out of 37 participants completed the workshop and skill assessment. Significant improvements were observed in both sigmoid colon and terminal ileum ultrasound scores after training ($P < 0.001$), with effect sizes of $r = 0.89$ and $r = 0.86$, respectively. The MPS was achieved by 67.65% of participants for the sigmoid colon and 50% for the terminal ileum.* ***Conclusion:*** *A mastery learning–based workshop significantly enhanced IUS skill acquisition among internists and gastroenterologists. Based on the MPS criteria, approximately one-third of participants would require additional training for sigmoid colon scanning, while about half would benefit from further training in terminal ileum scanning.*

Keywords: *Inflammatory bowel disease; ultrasonography; education, medical, continuing.*

INTRODUCTION

Intestinal ultrasound (IUS) has emerged as a transformative tool in managing inflammatory bowel disease (IBD), particularly for monitoring disease activity. Its high sensitivity and specificity establish IUS as a valuable alternative for IBD assessment, thereby reducing the need for frequent colonoscopies or esophagogastroduodenoscopies (EGD).[1] Furthermore, IUS confers substantial patient convenience, as it requires neither fasting nor bowel preparation, making it a more accessible and comfortable option for routine

monitoring.[2]

IUS has gained widespread recognition in Europe for its role in IBD management over the past decade. In contrast, its implementation in Indonesia remains in the early stages; for example, Cipto Mangunkusumo National General Hospital and Fatmawati General Hospital initiated its adoption in August and September 2024, respectively. Although Indonesian internists and gastroenterologists are proficient in abdominal ultrasound, applying ultrasound specifically for bowel assessment is relatively novel. Moreover, mastering IUS is challenging because of the complexities introduced by bowel gas and anatomical variations.[3]

To address the knowledge and skill gap in IUS among Indonesian physicians, the Indonesian Society for Digestive Endoscopy (ISDE) conducted the country's first IUS in IBD workshop intended for internists and gastroenterologists. This workshop occurred during the Jakarta International Gastrointestinal Endoscopy Symposium and Live Demonstration (JIGES-LD) 2025. It featured a combination of didactic lectures and hands-on training using healthy subjects and IBD patients. A total of 37 doctors participated under the guidance of six expert faculty members, marking a significant milestone in expanding IUS proficiency in Indonesia.

The workshop's primary objective was to equip participants with the necessary skills to perform IUS on healthy individuals and IBD patients. Unlike conventional training methods, the workshop was structured around mastery learning principles—including deliberate practice, timely feedback, and the expert performance approach (EPA)—which have been successfully applied in gastrointestinal endoscopy training.[4-7] However, integrating these principles into IUS training remains limited. The present study investigated the feasibility of incorporating mastery learning into an IUS workshop, hypothesizing that applying these principles over two days would effectively impart the requisite skills for IUS performance.

METHODS

A retrospective study was conducted using data from the IUS workshop held on February 10–11, 2025, during JIGES-LD at the Indonesian Clinical Training and Education Center (ICTEC) in Jakarta, Indonesia.

Description of Study Subjects

Thirty-seven internists and gastroenterologists representing diverse Indonesian institutions registered for the two-day workshop. This study included only the participants who completed all workshop sessions.

Institutional Review Board Approval

The research described herein adhered to the principles of the Declaration of Helsinki and received approval from the Ethics Committee of the Faculty of Medicine, Universitas Indonesia—Cipto Mangunkusumo Hospital (registration number: KET-431/UN2.F1/ETIK/PPM 00.02/2025). Consent to participate was provided upon submission of the complete questionnaire, and privacy and confidentiality were maintained throughout.

Mastery Learning Approach

The workshop included nine lectures lasting 20 to 30 minutes and four hands-on sessions, each of two hours. Three hands-on sessions were conducted with healthy individuals, and one was performed with patients diagnosed with IBD. Additional practice opportunities were provided during breaks and after the official sessions. Six ultrasound stations were established, each led by one expert faculty member, attended by six to seven participants, and supported by one healthy individual or IBD patient. Six ultrasound machines were used: two GE Logiq P10 units, one GE Logiq Fortis unit, and three Philips Epiq Elite Diagnostic Ultrasound System GI Premium units.

A flipped learning model was employed, requiring participants to review online materials in advance to engage in focused, deliberate practice during the workshop. During the hands-on sessions, trainers provided real-time feedback to enhance skill development. The EPA framework was used to break down the IUS procedural steps into a standardized 6-point checklist, which six assessors applied to evaluate skill acquisition in scanning the sigmoid colon and terminal ileum.

Participants underwent IUS skills testing on healthy individuals before and after the

workshop. Standardized checklists were used to assess baseline (pre-test) and post-test performance. Minimum passing standards (MPS) were determined using the modified Angoff method by two faculty members who were certified in mastery learning training.

Study Tool

A four-item questionnaire was administered to collect baseline characteristics, such as demographic data (age, sex), professional background (internists, gastroenterologists, or others), and previous experience with IUS. In addition, standardized checklists for the sigmoid colon and terminal ileum were employed for skill evaluation.

Data Collection and Statistical Analysis

Data were analyzed using SPSS software (version 26.0; IBM Corp., Armonk, NY, USA). The Shapiro-Wilk test assessed the normality of continuous variables. Results are reported as mean ± standard deviation (SD) for normally distributed data, whereas non-normally distributed data are presented as median with range. Paired t-tests and Cohen's d effect sizes (with values > 0.8 indicating a significant effect) were computed to analyze learning outcomes for normally distributed data. Wilcoxon signed-rank tests and corresponding effect sizes (with r > 0.8 considered significant) were calculated for non-normally distributed outcomes. Aside from basic AI-assisted grammar and spelling corrections, no artificial intelligence (AI) tools were employed during the research.

RESULTS

A total of 37 participants enrolled in the course; however, three were excluded due to incomplete participation or missing responses, resulting in a final dataset of 34 subjects. **Table 1** summarizes the baseline characteristics. The subjects had a median age of 39 years (33–73), with males representing 76.5% of the sample and females 23.5%. Most subjects were internists (73.5%), followed by gastroenterologists (23.5%) and general surgeons (2.9%). Three participants (8.82%) had prior experience performing IUS.

Table 1. Demographic Characteristics of Participants

Characteristic	N (%)
Age (yr) (median(min-max))	39 (33-73)
Male sex	76.5
Profession	
Internists	23.5
Gastroenterologists	67.6
General surgeon	2.9
Practiced IUS before	
No	91.18
Yes	8.82

Values are presented as a number (%). IUS, intestinal ultrasound.

Using a 6-point sigmoid colon checklist, the median pre-test score was 0 (range: 0–100), and the median post-test score was 100 (range: 0–100). Similarly, the 6-point terminal ileum checklist yielded a median pre-test score of 0 (0–100) and a median post-test score of 91.67 (16.67–100).

A total of 31 cases for the sigmoid colon and 33 cases for the terminal ileum were evaluated for rank differences between pre- and post-tests after excluding tied cases. In the sigmoid colon group, every subject demonstrated a positive difference, meaning the post-test scores exceeded the pre-test scores; in contrast, two subjects in the terminal ileum group had a negative difference. Further analysis revealed a standardized test statistic (Z) of 4.943 ($P < 0.001$) with an effect size of r = 0.89 for the sigmoid colon group, and a Z-value of 4.948 ($P < 0.001$) with an effect size of r = 0.86 for the terminal ileum group (**Figure 1**). Minimum Passing Standards (MPS) were achieved by 67.65% of subjects in the sigmoid colon group and 50% in the terminal ileum group.

The median terminal ileum pre-test and post-test scores among internists were 0 (range: 0–33.33) and 100 (range: 33.33–100), respectively. In the gastroenterologist group, the median terminal ileum pre-test score was 0 (0–16.67), and the median post-test score was 100 (33.33–100). Regarding sigmoid colon performance, internists obtained median pre-test and post-test scores of 0 (range: 0–50) and 100 (range: 50–100), respectively, while gastroenterologists recorded median scores of 0 (range: 0–16.67) for pre-test and 100 (range: 66.67–100) for post-test.

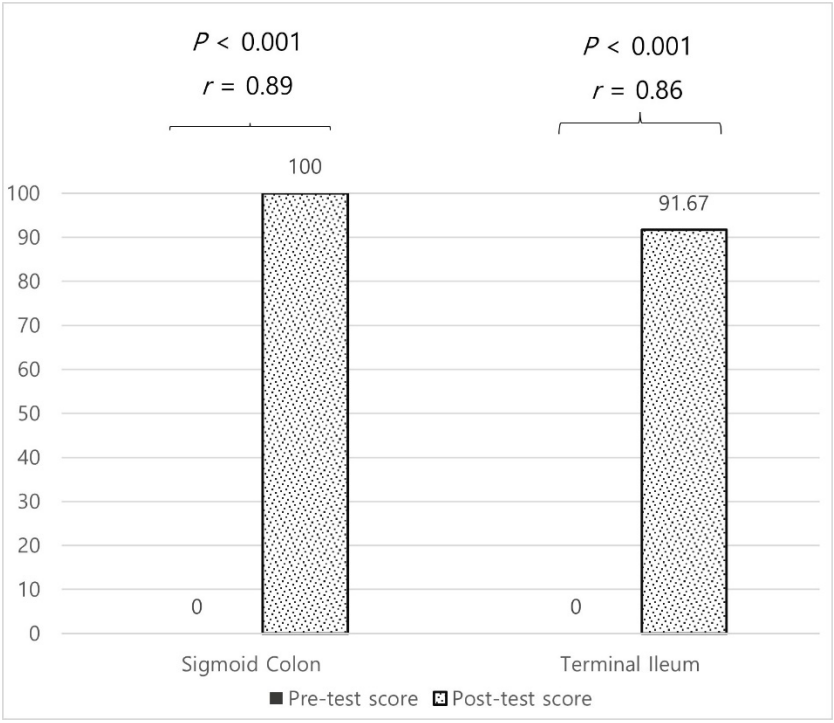

Figure 1. Differences between pre-test and post-test median scores for the Sigmoid Colon and Terminal Ileum Groups

DISCUSSION

The principles that underpin mastery learning emphasize deliberate practice, timely feedback, and an expert performance approach. Simulation-based mastery learning (SBML) has demonstrated success in gastrointestinal endoscopy training, as documented by Nguyen et al. and Maulahela et al.[5,8] Further research has shown that mastery learning is effective across various medical education domains. For example, a randomized controlled trial among radiology residents demonstrated that using SBML for abdominal diagnostic ultrasound significantly improved early scan performance and required fewer practice sessions to achieve the same proficiency level as the standard simulation group.[9] Similar findings were reported by Britz et al., who highlighted the success of mastery learning in enhancing undergraduate medical students' ability to perform focused assessment with sonography for trauma (FAST).[10]

Despite these successes, implementing mastery learning in IUS training remains underutilized. Unlike gastrointestinal endoscopy or abdominal ultrasound simulations, our study focused on performing real-life assessments in healthy subjects and patients with IBD—an approach characterized by a steep learning curve. To the best of our knowledge, no previous study has investigated the implementation of mastery learning in the context of IUS training.

The results demonstrate a significant effect of the mastery learning approach on both sigmoid colon and terminal ileum scanning. The present study's findings indicate that mastery learning yields reliable and consistent improvements in educational outcomes, particularly within IUS training. Participants represented diverse demographic backgrounds from institutions across Indonesia and possessed varying levels of prior IUS experience. The variability in participant backgrounds suggests that, despite differences in baseline skills, the observed post-test score improvements underscore the robust effectiveness of the training program in equipping physicians with essential intestinal

ultrasound competencies.

The observation of negative ranks in the terminal ileum group, where some participants achieved higher pre-test scores than post-test scores, indicates that a subset of physicians experienced a decline in performance after training. Although the overall trend demonstrated a significant improvement in ultrasound skills, these cases underscore the complexity of skill acquisition and point to potential challenges during training. A suspected contributing factor is the difference in the healthy individuals evaluated between the pre-test and post-test sessions. Some participants may have struggled with probe angulation, compression techniques, or real-time interpretation, leading to lower post-test scores.

Although the minimum passing standard (MPS) was set to be 100% for all groups, only 67.65% of subjects in the sigmoid colon group and 50% in the terminal ileum group met this benchmark. One plausible explanation is the limited supervised hands-on practice time, as each station was shared among six to seven participants.

The current investigation has several limitations. First, its retrospective design may introduce potential data collection and interpretation biases. Second, the relatively small sample size may limit the generalizability of the findings. Future prospective studies with larger cohorts are recommended to further validate the effectiveness and consistency of mastery learning in IUS training and assess its long-term impact on skill retention and clinical application.

CONCLUSION

The present study demonstrates that a mastery learning–based workshop significantly enhances intestinal ultrasound (IUS) skill acquisition among Indonesian internists and gastroenterologists. Participants improved sigmoid colon and terminal ileum scanning scores substantially, with large effect sizes observed. Nevertheless, not all participants met the minimum passing standard, indicating that additional hands-on training may be necessary. These results support the feasibility and effectiveness of mastery learning in IUS training. Further studies with a prospective design and larger samples are urgently needed to consistently confirm current findings.

ACKNOWLEDGMENTS

None.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

FUNDING SOURCE

No specific institution or organization funded this study.

COPYRIGHT LICENSE STATEMENT

We will comply with the copyright and license requirements outlined in the journal's submission guidelines.

REFERENCES

1. Andrzejewska M, Grzymisławski M. The role of intestinal ultrasound in the diagnosis of bowel diseases. Prz Gastroenterol. 2018;13(1):1-5.
2. Ong AM. Utility of gastrointestinal ultrasound in functional gastrointestinal disorders: A narrative review. World J Meta-Anal. 2020;8(2):109-18.
3. Frias-Gomes C, Torres J, Palmela C. Intestinal ultrasound in inflammatory bowel disease: A valuable and increasingly important tool. GE Port J Gastroenterol. 2021;29(4):223-39.
4. Maulahela H, Annisa NG, Konstantin T, Syam AF, Soetikno R. Simulation-based mastery learning in gastrointestinal endoscopy training. World J Gastrointest Endosc. 2022;14(9):512-23.
5. Nguyen-Vu T, Malvar C, Chin YK, et al. Simulation-based mastery learning (SBML) for rapid acquisition of upper endoscopy knowledge and skills: initial observation. VideoGIE. 2020;5(6):222-5.
6. Soetikno R, Asokkumar R, McGill SK, Kaltenbach T. Simulation-based mastery learning for practicing gastroenterologists-renewed importance in the era of COVID-19. Am J Gastroenterol. 2020;115(9):1380-3.
7. Soetikno R, Cabral-Prodigalidad PA, Kaltenbach T. Simulation-based mastery learning with virtual coaching: Experience in training standardized upper endoscopy to novice endoscopists. Gastroenterol 2020;159(5):1632-6.
8. Maulahela H, Soetikno RM, Kaltenbach TR, et al. Prospective study on comparison of simulation-based mastery learning versus conventional apprentice-based learning for basic endoscopy training. J Gastroenterol Hepatol. 2024;39(12):2804-10.

9. Østergaard ML, Rue Nielsen K, Albrecht-Beste E, Kjær Ersbøll A, Konge L, Bachmann Nielsen M. Simulator training improves ultrasound scanning performance on patients: A randomized controlled trial. Eur Radiol. 2019;29(6):3210-8.
10. Britz V, Sterz J, Vo SH, Carstensen P, Germanyuk A, Ruesseler M. Influence of the instructional approach "mastery learning" versus "see one, do one" on acquiring competencies in abdomen sonography: A comparative effectiveness analysis. Ultrasound in Med & Biol. 2020;46(8):1934-40.