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Effects of Simulation-Based Learning in a Flipped Classroom vs an Interactive Lecture on Performance, Engagement, and Learning Experience in Family Medicine Education: A Mixed-Methods Study

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Abstract

Background: Managing difficult patients in primary care requires clinical reasoning, communication skills, and reflective practice. However, opportunities for authentic, hands-on learning in undergraduate medical education remain limited. The flipped classroom approach enables accessible, competency-based learning in the digital era, in contrast to interactive lectures.

Objective: To evaluate whether a simulation-based flipped classroom approach was more effective than simulation-based interactive lectures in improving medical students' academic performance, engagement, and reflective learning.

Methods: An embedded mixed-methods study employing a quasi-experimental design and a descriptive qualitative approach was conducted among fifth-year medical students. The study compared 2 groups from the 2023 and 2024 academic years. In 2024, data were collected prospectively according to the lesson plan protocol, including lesson-learned reflection forms and summative academic achievement tests. Data from 2023 were collected retrospectively from existing records. Quantitative data were analyzed using statistical methods, while qualitative data were analyzed using document analysis.

Results: Students in the simulation-based interactive lecture group demonstrated significantly higher academic achievement than those in the simulation-based flipped classroom group ($P < .001$). Participation rates were 97.58% and 99.41%, respectively. Qualitative findings reflected positive perceptions of the course content, instructional methods, and the applicability of learning experiences to clinical practice. Two major themes emerged: 1) content knowledge and clinical application, and 2) enhanced learner engagement through active learning.

Conclusions: Integrating flipped classroom pedagogy with simulation-based learning provides an innovative instructional approach that enhances learner engagement. Although this approach may be less effective than simulation-based interactive lectures in improving academic achievement test scores, it better supports competency-based and meaningful learning beyond knowledge acquisition. Given the quasi-experimental design, students in the 2 groups may have differed in their individual learning abilities, behaviors, and health status, which may have influenced the outcomes.

Keywords: Simulation-based learning, Flipped classroom, Simulation-based interactive lectures, Primary care practice, Family medicine

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Introduction

Family medicine courses in undergraduate medical education in Thailand focus on holistic and comprehensive care for patients in primary care settings. Teaching difficult cases in this context is essential for students' clinical development. In recent years, instructional designs in medical education have evolved in response to technological advancements, with an increasing emphasis on student-centered approaches. Educators play a central role in course design, aligning teaching methods with learning objectives and students' diverse learning styles.[1,2]

Primary care serves as the foundation of the healthcare system and is central to the delivery of comprehensive, continuous, and patient-centered care. In primary care settings, physicians are frequently required to manage patients with complex, undifferentiated, and multifaceted health problems, often in the context of limited resources and diagnostic uncertainty. These clinical realities demand strong competencies in clinical reasoning, holistic assessment, decision-making, and continuity of care.[1,3]

Despite the critical role of primary care, medical students may have limited opportunities to systematically develop these competencies through traditional, lecture-based instructional approaches. There is a growing need for educational strategies that align with the principles of competency-based medical education and reflect the real-world complexity of primary care practice.[1]

The flipped classroom approach has gained increasing attention in medical education because it supports interactive and accessible learning in the digital era.[4] By enabling students to engage with learning materials at their own pace, it optimizes classroom time for discussion, problem-solving, and other active learning activities. However, effective implementation requires consideration of resource availability, faculty preparedness, and student preferences.[4] When integrated with flipped classroom pedagogy, simulation-based learning provides an authentic environment for applying knowledge, developing clinical decision-making skills, and reflecting on patient care in family medicine.[5]

Managing difficult patients in primary care requires effective clinical reasoning, communication skills, and reflective practice. However, opportunities for authentic, hands-on learning in undergraduate medical education remain limited. Simulation-based learning and flipped classroom pedagogy have each demonstrated positive educational effects, including improved learner engagement and performance.[5] Nevertheless, evidence regarding the combined use of simulation-based flipped learning, particularly in comparison with simulation-based interactive lectures in family medicine education, remains limited.

Previous quantitative studies have reported beneficial effects of simulation-based flipped learning on learner performance and engagement.[5] However, little is known about how medical students perceive and experience these learning environments or how such experiences may influence learning outcomes. A mixed-methods approach may therefore provide deeper insights into both measurable educational outcomes and the underlying mechanisms contributing to learner development.

In 2022, the Family Medicine course at Srinakharinwirot University in Thailand incorporated simulation-based learning for the first time in the topic module "Working With the Difficult Patient in Primary Care Settings". Students participated in the activities and provided feedback that informed adjustments in subsequent years. In clinical practice, students must deliberately develop both technical and nontechnical skills. However, limitations such as restricted time, large class sizes, and the rarity of some cases hinder experiential learning.

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This study aimed to evaluate the effectiveness of simulation-based flipped classroom pedagogy compared with simulation-based interactive lectures in improving medical students' academic achievement, engagement, and learning experiences. The study also explored students' experiences to better understand factors influencing learner engagement and development. These objectives are consistent with Kirkpatrick's evaluation model.[6,7] The findings may provide empirical evidence to inform pedagogical innovation in family medicine education and support the development of competent future physicians.

Methods

Study Design, Setting, and Participants

This educational study employed an embedded mixed-methods design within a quasi-experimental framework. Quantitative data were collected from both the intervention and comparison groups, whereas qualitative data were obtained exclusively from the intervention group to provide contextual insights into the learning experience. The qualitative component was embedded within the primary quantitative design and was used to complement and explain the intervention outcomes (Figure 1).

The study population comprised 335 fifth-year medical students from the Faculty of Medicine, Srinakharinwirot University, Thailand, during the 2023 and 2024 academic years. A census approach was employed, whereby all eligible students were included in the study. Participants were assigned to either the comparison group (n = 165; 2023 academic cohort) or the intervention group (n = 170; 2024 academic cohort). All participants had previously completed and passed the Family Medicine Practice I course at the fourth-year level.

The inclusion criteria were fifth-year medical students enrolled in the Family Medicine Practice II course and undertaking clinical practice at Panyananthaphikkhu Chonprathan Medical Center, Srinakharinwirot University. The exclusion criteria were students who did not attend the course or complete the summative academic achievement test.

For the qualitative component, reflective reports were included in the analysis if students had completed both questions.

Research Instruments

The study instruments included lesson plans and data collection tools: an academic achievement test and a lesson-learned reflection form.

The topic module, "Working With the Difficult Patient in Primary Care Settings", was a single instructional session focusing on the definition of difficult patients, contributing factors, and guidelines for managing difficult patients based on family medicine principles. The comparison group participated in a 3-hour session comprising an interactive lecture and simulation-based learning. The session began with a 5-minute pretest, followed by the interactive lecture and simulation-based learning, and concluded with a 5-minute posttest. The intervention group participated in simulation-based learning integrated with flipped classroom pedagogy. The instructional design comprised 3 phases. Pre-class activities included self-directed textbook study and group discussions. The 3-hour in-class activities consisted of 1) a 5-minute pretest, followed by group presentations, facilitated discussions, and instructor feedback, and 2) simulation-based learning sessions with facilitated discussions and instructor feedback. Post-class activities involved a summary of the learning content, followed by a 5-minute posttest and reflective questions. Both groups were taught by the same instructor and followed the same curriculum.

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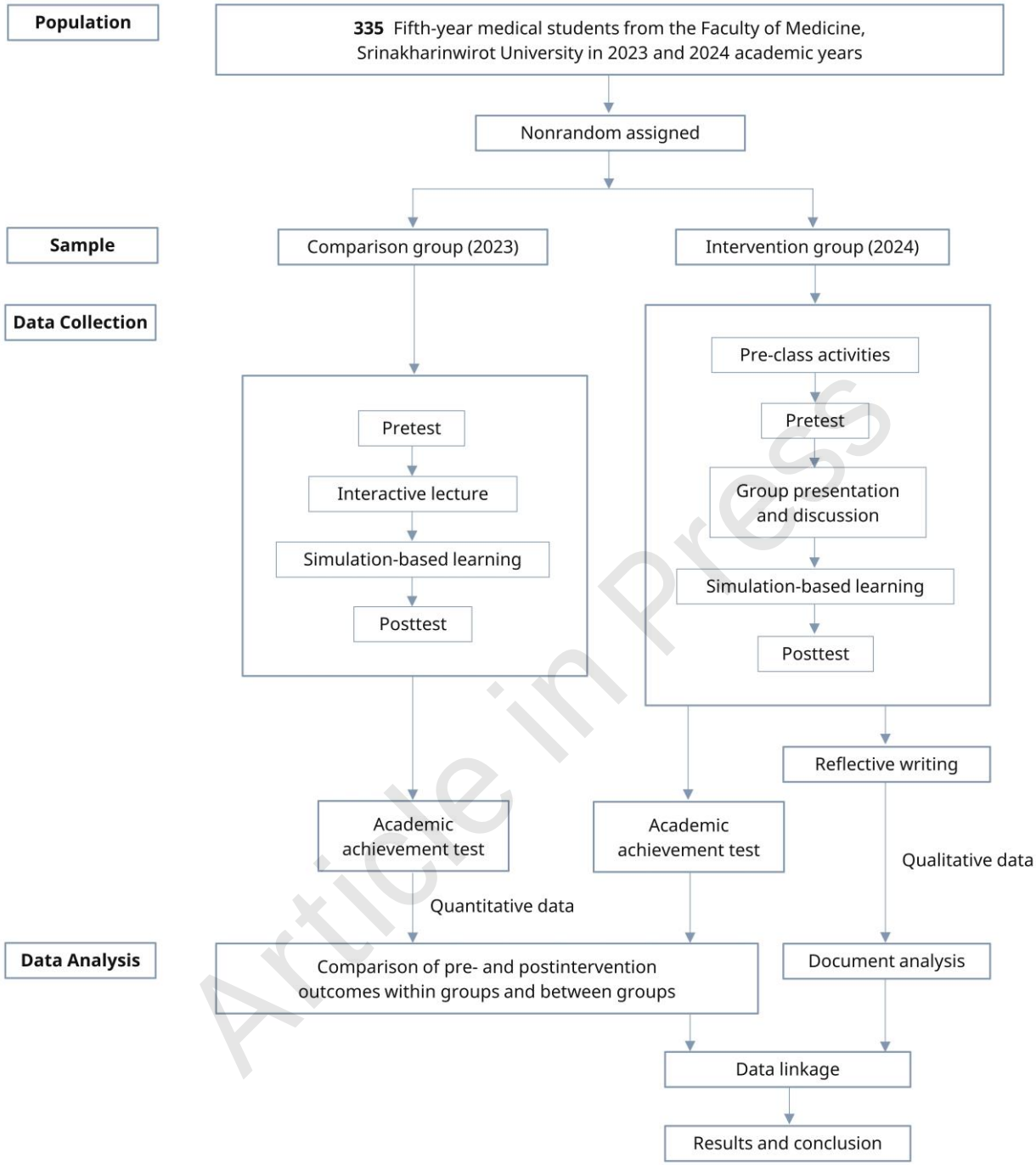
Figure 1. Flow of the Study



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Academic achievement was assessed using a 10-item multiple-choice test on the topic module "Working With the Difficult Patient in Primary Care Settings." The test measured applied knowledge aligned with the same cognitive domain learning outcomes for both groups and formed part of the routine end-of-clerkship summative assessment. The test was developed in alignment with the course learning outcomes and program

learning outcomes, as specified in the test specification table. The researcher, who was also the course instructor, developed 10 items assessing comprehension and application, which were reviewed by an expert committee. Content validity was evaluated by 3 independent specialists using the index of item-objective congruence, with values ranging from 0.50 to 0.60. Reliability was assessed using the Kuder-Richardson Formula 20, yielding a coefficient of approximately 0.60.

The pretest and posttest each consisted of a 5-item multiple-choice assessment based on the relevant module content. The pretest evaluated recall and applied knowledge to assess baseline comprehension prior to the applied learning session. The posttest assessed applied knowledge to evaluate overall comprehension and consolidation of learning. Both were used as formative assessments.

The 10-item multiple-choice test was part of the end-of-clerkship summative assessment, whereas a separate 5-item multiple-choice test was used for the pretest and posttest as formative assessments. Both tests covered parallel content and learning outcomes.

The lessons-learned reflection form was adapted from the PC003 satisfaction evaluation form[8] of Srinakharinwirot University and included closed-ended questions and reflective writing. Students were allocated 10 minutes for learning reflection and were asked to respond to 2 questions addressing 1) the key knowledge or insights gained from the lesson and 2) how these learnings could be applied to their future medical practice.

Data Collection

After obtaining ethical approval from the Human Research Ethics Committee, the study was conducted. Data collection for the 2024 academic year was conducted according to the lesson plan protocol. Participants received detailed information via an information sheet. Following the session, students were invited to complete the lesson-learned reflection form voluntarily and anonymously via a QR code linking to a Google Forms. At the end of the course, participants completed the summative academic achievement test. Data collection for the 2023 academic year was performed retrospectively, focusing on academic achievement scores and the proportion of classroom participation. Upon completion of data collection for both years, the principal investigator collated and verified all data to ensure their accuracy and integrity.

Data Analysis

Statistical analyses were performed using SPSS version 22.0 (IBM Corp) and Excel version 21.11 (Microsoft Corp). Normality of the data was assessed using the Kolmogorov-Smirnov test. Descriptive statistics were used to summarize participants' characteristics, including academic achievement and pretest and posttest scores obtained during the instructional sessions. Continuous variables were reported using the mean (SD) for normally distributed data, and the median (IQR) for nonnormally distributed data. Categorical variables were presented as frequencies and percentages. The Wilcoxon signed rank test was used to evaluate within-group changes from preintervention to postintervention. Between-group differences in postintervention outcomes were examined using analysis of covariance (ANCOVA), with baseline (preintervention) scores included as a covariate. Statistical significance was set at $P < .05$, unless otherwise specified. Class participation in the 2 groups was compared using frequencies and proportions, calculated as the number of participating students divided by the total number of students registered in the course.

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Qualitative data obtained from documents were analyzed using Braun and Clarke's 6-phase reflexive thematic analysis.[9] The medical students' written reflections were revisited multiple times at different stages of the analysis to enhance data familiarization and support the trustworthiness and consistency of interpretation. Codes were generated systematically and collated into themes based on recurring patterns across participants' perspectives. Analysis continued until data saturation was achieved with a higher-order grouping method. Themes were reviewed, refined, and clearly defined to ensure coherence and distinction. Representative quotations were selected to support the interpretation. The qualitative findings were integrated with the quantitative results using a data-linkage strategy. Reporting followed the Good Reporting of a Mixed Methods Study guidelines.[10]

Reflexivity was maintained throughout data collection and analysis through continuous critical reflection on the researcher's professional background and its potential influence on participant responses, data interpretation, and theme development.

Results

A total of 335 fifth-year medical students from the Faculty of Medicine, Srinakharinwirot University, enrolled during the 2023 and 2024 academic years, were assessed for eligibility. Participants were purposively allocated to either the comparison group (2023 cohort; n = 165) or the intervention group (2024 cohort; n = 170). In the comparison group, 4 students were excluded because they did not attend the course, leaving 161 participants for analysis (90 females [55.90%] and 71 males [44.10%]). In the intervention group, one student was excluded for the same reason, resulting in 169 participants for analysis (92 females [54.44%] and 77 males [45.56%]). All remaining participants completed the course and were included in the final analysis (Figure 2).

Academic Achievement

The findings revealed that, out of a total possible score of 10 points, the comparison group achieved a mean (SD) test score of 9.48 (0.64), with scores ranging from 8 to 10. Conversely, the intervention group obtained a mean (SD) test score of 9.04 (0.82), with scores ranging from 6 to 10. In the between-group analysis, the ANCOVA revealed that after controlling for baseline differences (pretest scores), there was a significant main effect of groups on the postintervention outcomes, (F[1,260] = 11.74, P < .001, partial η^2 = 0.043) (Table 1).

Pretest and Posttest Scores Within Instructional Sessions

For the comparison group, participants achieved a mean (SD) pretest score of 4.45 (0.73) out of 5 points, with a median (IQR) score of 5 (4-5). The mean (SD) posttest score was 4.86 (0.46) out of 5 points, with a median (IQR) score of 5 (5-5). A comparison of the pretest and posttest scores demonstrated a statistically significant difference (Z = -5.481, P < .001).

For the intervention group, participants achieved a mean (SD) pretest score of 2.33 (1.01) out of 5 points, with a median (IQR) score of 2 (2-3). The mean (SD) posttest score was 4.11 (0.79) out of 5 points, with a median (IQR) score of 4 (4-5). A comparison of the pretest and posttest scores revealed a statistically significant difference (Z = -8.282, P < .001) (Table 1).

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Figure 2. Diagram of Enrollment

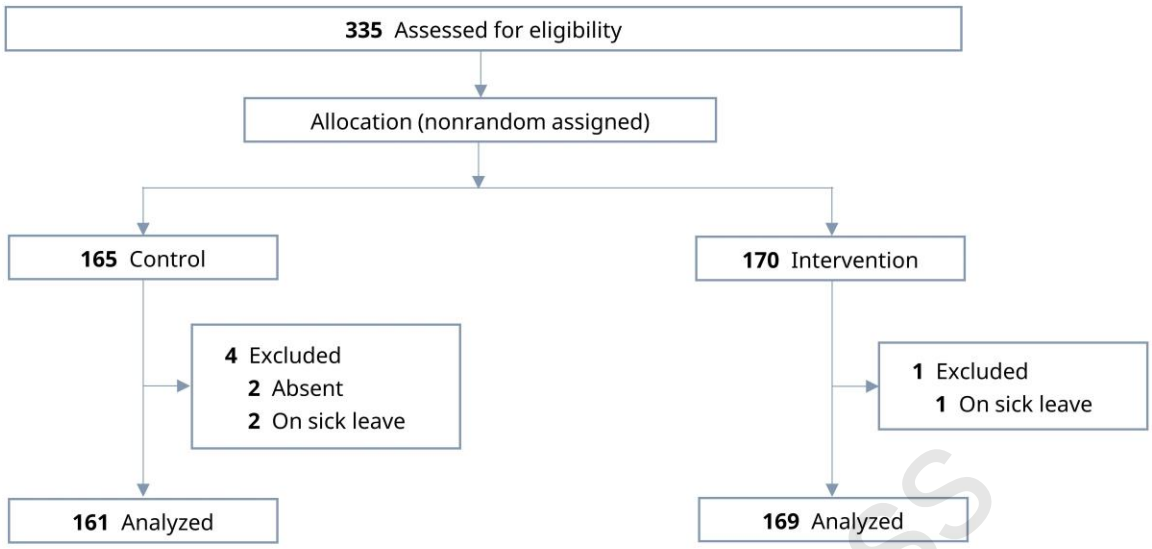

Table 1. Comparison of Preintervention and Postintervention Outcomes Within Groups and Between Groups

Group	Mean (SD)		Within-Group Changes		Academic Achievement Test, Mean (SD)	Between-Group Changes	
	Pretest	Posttest	*Z*	*P* Value		*F*(*df*)	*P* Value
Covariate (pretest)	NA	NA	NA	NA	NA	0.034(1)	.854
Comparison group	4.45 (0.73)	4.86 (0.46)	-5.481	< .001	9.48 (0.64)	11.74(1)	.001
Intervention group	2.33 (1.01)	4.11 (0.79)	-8.282	< .001	9.04 (0.82)		
Error	NA	NA	NA	NA	NA	Error *df* = 260	

Abbreviations: *df*, degree of freedom; NA, not applicable.

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Student Participation

With regard to student participation across the instructional approaches, in the group receiving interactive lecture-based instruction integrated with simulation scenarios, 2 students were absent and 2 were on sick leave. Consequently, the attendance rate for this group was 97.58%. In contrast, in the group receiving flipped classroom instruction integrated with simulation scenarios, one student was on sick leave, resulting in an attendance rate of 99.41%.

Medical Students' Lessons Learned

Following completion of the session, medical students who participated in flipped classroom instruction integrated with simulation-based learning demonstrated a variety of learning outcomes, encompassing content comprehension, pedagogical experiences, and anticipated applications in future practice. Of the 154 reflective reports submitted, 4 were incomplete and did not contain responses to both questions. A total of 150 reflective reports were included in the analysis. Most students concentrated on articulating the knowledge they had gained, while some provided personal reflections and discussed the potential application of this knowledge in future practice.

The analysis identified 2 overarching themes: 1) content knowledge and clinical application, and 2) enhanced learner engagement through active learning (Table 2).

The first theme, content knowledge and clinical application, comprised 2 subthemes: 1) nonjudgmental listening and self-awareness, and 2) holistic, patient-centered care beyond pharmacological management. In the first subtheme, medical students demonstrated enhanced self-awareness and nonjudgmental listening skills through participation in these teaching and learning activities. In the second subtheme, students developed an understanding of the importance of providing patient care across multiple dimensions, beyond the physical domain.

The second theme, enhanced learner engagement through active learning, reflected students' increased engagement, motivation to participate in learning activities, and enjoyment of the teaching and learning sessions. Students were able to synthesize the key messages from the learning activities, thereby enhancing their understanding of the practical application of the underlying principles.

Table 2. Key Themes and Subthemes Describing Medical Students' Lessons Learned

Theme	Subtheme	Quotation
Content knowledge and clinical application	Nonjudgmental listening and self-awareness	[ID19] "Always keep the patient in mind, listen attentively, self-assess my own feelings, and apply various techniques with patients in the future." [ID23] "I will strive not to judge patients based on first impressions and will make an effort to understand that each patient comes to us because they are genuinely unwell and experiencing discomfort." [ID67] "While seeing patients at the outpatient clinic, if I encounter a patient who is difficult to communicate with, I will remain calm, stay focused, listen carefully, and explain matters to the patient patiently." [ID70] "I will listen to patients more attentively, allow them the opportunity to express their concerns, identify key issues, and respond appropriately." [ID87] "I found that active listening and using the IFFE questions help me explore the patient's concerns more deeply and get a better understanding of what they are going through." [ID121] "I learned to look at things from a new perspective. The patient may not actually be a difficult patient to manage; it may actually be the doctor who makes the patient seem difficult to manage." [ID132] "Listening to patients with an open mind and without judgment allows us to understand the bigger picture of their lives. This may help us see the underlying problems that they may be facing." [ID150] "When dealing with difficult patients, I will remain calm, listen attentively, and respond appropriately to each type of patient. For instance, with a sad patient, I will listen carefully without immediately seeking a solution, and with an irritable patient, I will listen while avoiding escalation."

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Table 2. Key Themes and Subthemes Describing Medical Students' Lessons Learned (Continued)

Theme	Subtheme	Quotation
	Holistic, patient-centered care beyond pharmacological management	[ID09] "I learned how to adapt to different types of challenging patients, whether it's because of their health, personality, finances, or expectations." [ID25] "I learned how to handle difficult patients in different situations. I realized that many things can make patient care challenging, such as the patient's personality, religious beliefs, health beliefs, and emotional state. Even as doctors, having good knowledge and confidence does not always make these situations easy. The BATHE technique is one approach that can help us build a better doctor-patient relationship and, in turn, improve the treatment process and outcomes." [ID48] "I will apply this by ensuring that I address not only the specific disease but also other concerns of the patient, rather than focusing solely on the medical condition." [ID71] "I learned how to manage challenging patients and, more importantly, I realized that patients do not always choose to ignore our advice. Sometimes, there are underlying reasons that we may not see at first. By understanding their concerns and addressing the real problem, we can better support them in continuing their treatment and coming to their appointments regularly." [ID95] "I apply this to patient care by designing a customized approach to handling each patient, rather than using a one-size-fits-all approach." [ID100] "I learned that holistic care allows us to treat patients as people, not just as a disease. By looking at the patient as a whole, we can better understand their needs and provide more appropriate support in the long term, rather than focusing only on treating the disease."
Enhanced learner engagement through active learning	None	[ID04] "Role-playing is fun and helps me remember the material better." [ID11] "I was able to observe my peers' perspectives in every activity, which provided me with new insights." [ID14] "I like presenting in front of the class because it's not boring, and I'm curious to see how everyone handles different types of patients." [ID38] "Role-playing lets me see what I can improve and also gives a chance to practice communicating with patients." [ID39] "Using case examples and role-playing really makes me think and apply what I learn, and it feels very realistic." [ID60] "There are activities to do, so I don't get sleepy. It's exciting and makes learning enjoyable." [ID76] "I studied part of the material on my own and was able to reflect and analyze it through both my group's simulation scenarios and those of my peers."

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Table 2. Key Themes and Subthemes Describing Medical Students' Lessons Learned (Continued)		
Theme	**Subtheme**	**Quotation**
		[ID77] "I prepared before class. In class, examples from peers' role-play activities and the instructor's summary helped me understand the content better and see the concepts more clearly."
		[ID80] "The instructor encouraged us to think creatively and created an open environment where we felt comfortable sharing our ideas and opinions."
		[ID102] "Simulated scenarios make it much easier to understand and picture things compared to just listening to lectures."
		[ID105] "Doing role-plays and then summarizing makes the content more interesting. If everyone summarizes their part first and then presents, it's quicker and less boring."

Discussion

Medical students who received interactive lecture-based instruction integrated with simulation scenarios achieved significantly higher academic outcomes than those who received flipped classroom instruction integrated with simulation. This difference may be explained by several contributing factors.

In an interactive lecture, learners primarily receive information provided by the instructor, whereas a flipped classroom requires learners to actively engage with and construct knowledge before and during class. Therefore, unfamiliarity with the flipped classroom approach may have contributed to lower examination scores among some learners, consistent with constructivist learning theory.[11] However, learner readiness varied, as not all students engaged in self-study prior to class, which is consistent with qualitative findings derived from reflective reports. Differences in prior knowledge and unfamiliarity with the flipped approach may have increased cognitive load.[12] Therefore, instructors should assess students' prior knowledge before in-class activities and allocate adequate time for clarification and questions. Following simulation-based learning, evidence of knowledge transfer and deeper learning was observed, consistent with the qualitative findings derived from reflective reports. However, after controlling for baseline scores, group allocation remained significantly associated with post-intervention outcomes, with effect sizes ranging from small to moderate. Additionally, Levene's test of equality of error variances indicated that the error variances were equal across the 2 groups. The mean change was 0.41 in the control group and 1.78 in the intervention group, resulting in a between-group difference in mean change of 1.37. These findings indicate that the intervention group demonstrated a greater mean change than the control group.

This finding may not be directly comparable to the study by Saeed et al,[5] which evaluated the effectiveness of hybridizing video-based learning with simulation in a flipped clinical skills course for fourth-year medical students at Aga Khan University, Pakistan, and reported significant improvements in self-efficacy and objective structured clinical examination (OSCE) performance. The discrepancy may be attributed to differences in instructional design, pre-class learning activities, and assessment strategies. In Saeed et al's study,[5] pre-class preparation involved individual video-based self-study, whereas the present study

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combined self-study with small-group case discussions. Furthermore, the assessment focus differed across studies in accordance with Bloom's taxonomy: the current study assessed cognitive outcomes using multiple-choice questions, while Saeed et al[5] primarily evaluated psychomotor outcomes through OSCEs.

Accordingly, the effectiveness of instructional approaches is context-dependent and shaped by learner characteristics, teaching methods, and assessment strategies. These findings highlight the importance of intentional instructional design, in which educators critically assess learner readiness, align teaching strategies with assessment tools, and tailor methods to the specific educational context. Rather than advocating a single "best" approach, faculty should prioritize optimizing instructional effectiveness in accordance with intended learning outcomes. Furthermore, these results emphasize the value of faculty development program that equip instructors with the skills to design, implement, and evaluate context-sensitive, evidence-based teaching practices.

Posttest scores were significantly higher than pretest scores in both groups, indicating that both instructional strategies supported learning. Greater score improvement was observed in the group receiving flipped classroom instruction integrated with simulation scenarios than in the comparison group, which may reflect differences in the educational impact of the 2 approaches. Descriptive statistics further illustrate performance levels and score distributions within each group. The findings of this study also suggest that the learning activities facilitated knowledge construction among learners, consistent with the principles of constructivist learning theory.[11] At the same time, the increase in posttest scores reflects experiential learning processes in which learners engaged in reflection, developed understanding, and applied it to future contexts, aligning with Kolb's experiential learning theory.[13] Furthermore, these results are consistent with cognitive load theory, which posits that appropriately designed learning activities, matched to learners' abilities, can reduce cognitive load and enhance learning.[12] The improvement in scores under both instructional approaches indicates that the activities were well designed and within the learners' capabilities during the session.

The results of this study align with previous research on active learning and the use of simulation. For example, a 2016 randomized controlled trial comparing high-fidelity simulation with lecture-based education in preclinical medical students reported that both approaches significantly improved posttest scores, with the simulation group demonstrating superior long-term knowledge retention.[14] These findings are also consistent with a 2024 study on the effectiveness of a simulation-based clinical research curriculum for undergraduate medical students, which employed a pre-post intervention design with an external control group. The study reported that students demonstrated significant improvements in both knowledge and practical skills after participating in the simulation-based curriculum.[15] This highlights that appropriately designed learning activities can lead to significant within-group gains in student learning outcomes, consistent with qualitative findings derived from reflective reports.

Qualitative data from students' reflective reports revealed that students in the flipped classroom with simulation reported learning outcomes across content knowledge, instructional processes, and future application, at superficial, intermediate, and deep levels.[16] Some students were able to critically compare flipped classroom and interactive lecture approaches and reflect on applying simulation-based practice to clinical settings. The flipped classroom approach enhanced some students' understanding of the course content and encouraged their participation in classroom activities (ID76 and ID77).

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These findings suggest that active learning requires time for reflection, and instructors should design activities with prompts or guiding questions to support deeper experiential learning.[13] These findings align with MacAskill et al,[17] who reported that creative reflective learning fosters a sense of belonging, supports interpersonal skills, and promotes personal development. This approach also facilitates the holistic development of medical graduates and allows instructors to address diverse learner needs through innovative, nontraditional approaches.

Overall, students demonstrated enhanced self-awareness, nonjudgmental listening skills, and a holistic approach through participation in this session, which may contribute to deeper learning and represent an important foundation for future medical practice. These outcomes may be associated with the active learning design of the activity, which was intended to promote learner engagement and structured reflection through end-of-session reflective writing. This interpretation is consistent with the quantitative findings, which indicated higher participation in the intervention compared with interactive lecture-based simulation instruction. These findings align with those of Khandelwal et al,[18] who reported that a flipped classroom format combined with simulation-based sessions facilitated the incorporation of contemporary professionalism issues related to social media. They are also consistent with findings by Gostelow et al[19] and Qi et al,[20] which suggested that flipped learning may enhance clinical relevance and learner engagement in population health and person-centered care. Taken together, these findings suggest that the educational value of the intervention extends beyond examination performance, encompassing broader dimensions of learning relevant to clinical practice.

Overall, the outcome evaluation, guided by Kirkpatrick's evaluation model[6,7] at levels 1 and 2, demonstrated both students' satisfaction with the learning experience and their learning outcomes. Students' perceptions provided evidence of their satisfaction, while the formative and summative test scores reflected their achievement of the intended learning outcomes.

In accordance with the study objectives, simulation-based learning integrated with a flipped classroom approach was associated with enhanced engagement, whereas interactive lecture-based instruction integrated with simulation scenarios was associated with higher final examination scores. These findings suggest differential effects of instructional approaches across cognitive and noncognitive domains of learning.

The results highlight the importance of aligning pedagogical strategies with intended learning outcomes, particularly when balancing knowledge acquisition and broader competencies such as engagement and reflection. Further research is warranted to explore the sustainability of these effects and their transferability across contexts and learner populations.

Strengths and Limitations

A key strength of this study is its mixed-methods design, which enabled the assessment of instructional effectiveness through both quantitative and qualitative data. This approach provided a comprehensive understanding of student satisfaction and learning outcomes, consistent with levels 1 and 2 of Kirkpatrick's evaluation model.[6,7]

This study has several limitations. Due to the quasi-experimental design, students in 2 groups may have differed in individual learning abilities, behaviors, and health status, which may have influenced the outcomes. However, the application of ANCOVA likely reduced the potential confounding effect of baseline differences in prior knowledge.

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Reflective reports may be limited in depth, as time constraints may have restricted students' opportunities for sustained reflection and critical analysis. However, immediate post-session reflective writing may reduce recall bias by capturing more contemporaneous perceptions of the learning experience. Behavioral change at level 3 of the Kirkpatrick model was not assessed, limiting conclusions regarding the transfer and sustained application of learning in practice. As a single-center study, the findings may have limited generalizability and should be interpreted in the context of the local educational setting. To enhance the confirmability of the findings, researcher triangulation should be employed. Despite these limitations, the findings offer valuable insights for instructional planning and future course development.

Implications

From an implementation perspective, the findings may inform how this approach can be translated into educational practice in primary care settings. At the educational level, the use of simulation integrated with a flipped classroom may support competency-based curriculum design and enhance learner engagement, contributing to the development of knowledge, skills, and professional attitudes.

There is no single optimal approach to instructional design; therefore, implementation should be adapted to the context and learner needs. In a flipped classroom with simulation, pre-class activities should be designed to maintain an appropriate cognitive load, and preassessment may be used to identify students' baseline understanding and address misconceptions before simulation activities. Instructional design should ensure alignment between learning objectives, prior knowledge, and assessment methods, in line with the principles of constructive alignment. In addition, sufficient time should be allocated for reflective activities to support critical thinking and deeper engagement with learning. These findings have implications for curriculum development, particularly in strengthening the integration of active learning and reflective practice in medical education.

Future Research

Future studies should employ experimental designs to further examine differences between instructional methods and compare them with other teaching models to enhance the generalizability of the findings. Adequate sample size calculations and randomization should also be considered to improve the balance of baseline characteristics between groups. In addition, longitudinal and mixed-methods research is needed to assess long-term learning outcomes, including knowledge retention and the transfer of learning to clinical performance during primary care clerkships. Such studies should particularly focus on clinical reasoning and the management of complex and undifferentiated patients to better understand the sustainability and real-world applicability of these competencies.

Conclusions

The integration of flipped classroom pedagogy with simulation-based learning represents an instructional approach that may enhance learner engagement and encourage active participation in the learning process. Although students in this group achieved lower academic achievement test scores than those receiving simulation-based interactive lectures, the approach appeared to support broader aspects of competency-

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based learning beyond knowledge acquisition alone. Due to the quasi-experimental design, students in the 2 groups may have differed in their individual learning abilities, behaviors, and health status, which may have influenced the outcomes. These educational features may contribute to the development of competencies relevant to the management of complex patients in future primary care practice.

Additional Information

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Ethics Approval: The study received an exemption certificate from the Human Research Ethics Committee of Panyananthaphikkhu Chonprathan Medical Center (EC 005/67) on 21 May 2024.

Clinical Trial Consideration: This study does not report on a clinical trial.

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Declaration of AI Assistance: The author used a generative AI tool (ChatGPT) in the preparation of this manuscript. The AI was utilized for language refinement, including grammar editing. All AI-generated content is based on real data and has been thoroughly reviewed and verified by the author to ensure accuracy, validity, and integrity. The author takes full responsibility for the content presented.

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Investigation: Passorn Rotpenpian
Methodology: Passorn Rotpenpian
Project Administration: Passorn Rotpenpian
Resources: Passorn Rotpenpian
Validation: Passorn Rotpenpian
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