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"Evaluating the effectiveness of the Saudi laboratory specialist licensure examination preparation program for the medical laboratory sciences interns: a quasi-experimental study"

Ahd A. Mansour[1] and Enas Gouda[2,3*]

Abstract

Background In Medical Laboratory Science (MLS), passing licensure examinations is essential to demonstrate professional competence worldwide. The Saudi Laboratory Licensing Examination (SLLE) is required by the Saudi Commission for Health Specialties (SCFHS) in Saudi Arabia. Success in the SLLE reflects candidates' proficiency in applying their knowledge and skills, serving as an indicator for evaluating the quality of MLS programs. Although preparation strategies for different healthcare licensure exams have been explored, a significant lack of research focuses on SLLE preparation programs for MLS students in Saudi Arabia. This gap became particularly evident when the MLS program at Fakeeh College for Medical Sciences (FCMS) observed a decline in first-attempt SLLE scores for students who graduated in the academic year 2021–2022. To address this research gap and the practical need for improved SLLE performance, this study aimed to develop, implement, and evaluate an SLLE preparation program for MLS interns at FCMS. This program is intended to equip interns with the essential knowledge and skills needed to enhance their chances of success in the SLLE and ensure their readiness for future careers.

Methodology A quasi-experimental study was conducted from 2022 to 2023 over six weeks at FCMS in Jeddah, Saudi Arabia. The study included all 18 MLS interns enrolled in the academic year 2022–2023, utilizing total population sampling. The participants were final-year students in their internship phase. The SLLE preparation program adhered to a structured three-phase conceptual framework: pre-training (planning), training (implementation), and post-training (evaluation). Data were collected through researcher-developed questionnaires adapted from previous studies and reviewed for content validity by medical education experts at FCMS. Reliability was ensured through expert review. Interns' knowledge was assessed with pre- and post-tests. A paired samples t-test was employed to analyze differences between pre- and post-test scores. Data analysis was performed using SPSS version 28, and statistical significance was established at $p < 0.05$.

*Correspondence:
Enas Gouda
enasgoudaa@gmail.com

Full list of author information is available at the end of the article

Findings The study included 18 MLS interns (14 females and 4 males). Level 1 (Reaction): Interns reported high satisfaction with all sessions, with ratings ranging from 94% to 100%. Level 2 (Learning): A significant improvement was observed in post-test scores across all subject areas compared to pre-test scores ($p < 0.05$). Level 3 (Behavior): Preceptors rated interns' clinical performance highly, achieving an average score of 4.6 out of 5.0, indicating successful application of knowledge in clinical settings. Level 4 (Results): All interns (100%) passed the SLLE on their first attempt one year after completing the program. Qualitative feedback further supported these findings, highlighting strengths in content delivery and instructional strategies.

Conclusion Incorporating the SLLE preparation program, along with mock assessments similar to the licensure examinations in the MLS program, enhanced their knowledge and skills, positively impacting interns' performance on the actual SLLE during their first attempt.

Keywords Saudi laboratory licensure examination, Saudi commission for health specialties, Medical laboratory sciences, Interns

Introduction

Medical laboratory specialists play an important role in the healthcare system, similar to other health professionals. The findings generated by medical laboratories are vital in clinical decision-making and significantly impact patient care [1–3]. Consequently, several training programs were developed to meet the growing demand. Worldwide, most of the MLS programs are designed to provide a comprehensive education that integrates in-depth theoretical knowledge with practical experience over a four-year curriculum. The program is followed by a one-year internship for clinical training in a hospital. During the internship year, students rotate through various sections of the hospital laboratories [4].

Over the years, the role of the medical technologist has evolved in response to advancements in technology, innovations in medical practices, and shifting social needs [5]. As a result, there is a heightened emphasis on quality assurance and professional accountability. Consequently, professionals need to stay informed about the latest developments in their fields to maintain their relevance in a continuously changing environment. The medical professions require foundational knowledge and the mastery of specific skills, as demonstrated by successful results in licensure examinations [6].

Worldwide, MLS graduates should pass the licensure examination. The purpose of the licensure examination is to ensure these examinees have the knowledge, skills, and ability to apply that knowledge professionally [7, 8]. Furthermore, the quality of the MLS program is evaluated based on the success of the licensure examination. Thus, graduates from colleges with high passing rates are considered highly skilled due to the quality of education they acquire from these institutions. Therefore, early identification of students' specific weaknesses, along with feedback, tutoring, and developing a program that includes practicing licensure examination questions, can improve the passing rate of the licensure examination [9].

Recent literature in health professions education highlights the growing effectiveness of structured licensure preparation programs. A previous study by Sales et al. (2022) examined a comprehensive review program for pharmacy students in Saudi Arabia and found that targeted preparation significantly improved performance on the Saudi Pharmacist Licensure Examination (SPLE) [10]. Similarly, Al-Sheikh et al. (2022) evaluated the impact of mock Saudi Medical Licensure Exams (SMLEs) with immediate personalized feedback on graduate scores and their performance in the actual SMLE. The study found that the performance of graduates improved in subsequent mock exams [11].

In addition, Brownie et al. (2015) and Alharbi (2021) provided evidence from nursing education, showing that interactive teaching strategies, formative assessments, and structured remediation courses can lead to measurable improvements in both academic performance and clinical readiness [12, 13]. Although these studies focus on related healthcare fields, there remains a gap in the literature specific to MLS licensure exam preparation in Saudi Arabia. This reinforces the importance of evaluating targeted interventions like the Saudi Laboratory Licensing Examination (SLLE) preparation program within the MLS context.

In Saudi Arabia, the Saudi Commission for Health Science (SCFHS) regulates all healthcare specialist certifications. It has approved the SLLE as a prerequisite for all Laboratory sciences graduates to practice the profession in hospitals in Saudi Arabia. At Fakeeh College for Medical Sciences (FCMS), the previous cohorts from the baccalaureate MLS program showed a significant decline in first-attempt pass rates among AY 2021–2022 graduates. This decline highlighted a significant gap in exam readiness that needed to be addressed promptly to maintain the high standards of our program and ensure the success of our graduates in their professional careers. To address this issue, we developed and implemented the SLLE preparation program for the first time, as no

previous intervention had been introduced to the previous program cohorts. This program aimed to enhance students' knowledge and skills specific to the SLLE content and familiarize students with the exam format and question types. By introducing this structured preparation program, we aimed to reverse the declining trend in first-attempt pass rates and better equip our students for success in the SLLE. This proactive approach not only addresses the immediate concern of declining performance but also serves to maintain the reputation of our institution in producing well-prepared MLS professionals. No prior research has explored the effectiveness of the SLLE preparation program in preparing MLS interns to pass the licensure examination in Saudi Arabia.

Methodology

Study design

This study is a quasi-experimental study to evaluate the effectiveness of the SLLE preparation program for MLS interns. It was conducted at FCMS in Jeddah, Saudi Arabia, during the academic year 2022–2023, and lasted for six weeks.

Participant and sampling

The study targeted all MLS interns enrolled at FCMS in the academic year 2022–2023 who were training at Dr. Soliman Fakeeh Hospital (DSFH) and attended all sessions of the SLLE preparation program. A total of 18 interns participated, representing the entire graduating cohort eligible to take the SLLE. As this study included the entire eligible cohort, self-selection bias was minimized. However, since participation in the preparation program was mandatory, potential biases related to motivation levels or prior knowledge were not fully controlled.

Inclusion criteria

- Enrollment in the MLS program at FCMS during the academic year 2022–2023.
- Completion of all SLLE preparation program sessions.
- Training at DSFH.

Exclusion criteria

- Intens at DSFH and not enrolled in FCMS.
- Not undergoing training at DSFH.

Sample size

The sample size was determined using the following equation: [13, 14]

$$n = 2\left[\frac{\left(Z_{\alpha/2} + Z_{\beta}\right) * \sigma}{\mu_1 - \mu_2}\right]^2$$

Where.

n = sample size.

Z α/2 = 1.96 (The critical value that divides the central 95% of the Z distribution from the 5% in the tail).

Zβ = 0.84 (The critical value that separates the lower 20% of the Z distribution from the upper 80%).

σ = estimate of the standard deviation = 9.6.

μ1 = mean score after the program = 40.8.

μ2 = mean score before the program = 16.9.

So, the calculated sample size = 6.

Program development and implementation

Pre-training phase (planning)

Preparation of the SLLE Preparation Program: An intensive program was developed based on the SLLE blueprint, which includes various subjects and specialties within the MLS: Hematology, Blood Banking, Microbiology, Immunology, Clinical Chemistry, Urinalysis, Histology, and Body Fluids. Each session featured two MLS subjects: Hematology and Blood Bank, Microbiology and Immunology, Clinical Chemistry and Urinalysis, Histology and Body Fluids. Pre-tests and post-tests were created for the interns, with the pre-test administered at the beginning of the session and the post-test being the same exam given at the end. Additionally, satisfaction questionnaires were developed to evaluate interns' perceptions of the SLLE preparation program.

Training phase (implementation)

The program consisted of weekly meetings that lasted for six weeks, running from 8:00 a.m. to 4:00 p.m. Each session followed a consistent format, starting with interns answering 30 multiple-choice questions for 45 minutes before the main session began. Then, the main sessions included an overview of the subject, which was a blend of interactive lectures and a discussion of the important concepts in the subject, delivered by an expert for 2 hours. Afterward, the interns took the same exam they had taken at the beginning of the session for 45 minutes.

Post-training phase (evaluation)

In this phase, the effectiveness of each session in the SLLE Preparation Program was assessed. The evaluation was conducted according to Kirkpatrick's Levels of Evaluation:

- **Level 1 Evaluation (Reactions)**: This level evaluates interns' perception of the training program through satisfaction questionnaires.

- **Level 2 Evaluation (Learning)**: This level involves assessing the extent of knowledge acquisition. Interns underwent testing both before the training (pre-test) and after the training (post-test) to measure their learning progress.

Level 3 evaluation (Behavior) This level evaluates the Preceptors' Feedback about interns' performance in the workplace after the SLLE Preparation Program. Preceptors were selected based on their direct supervision and close professional interaction with interns in the workplace. The selected preceptors held at least a BSc degree in MLS with a minimum of three years of work experience in the field. Additionally, preceptors were required to attend a structured preceptorship program designed to equip them with the necessary mentoring and evaluation skills to ensure consistency and reliability in their assessments. Each preceptor was responsible for directly training and communicating with the intern, accompanying them throughout their entire rotation. This evaluation was conducted six months after the program's implementation to allow sufficient time for behavioral changes to manifest in the workplace setting.

- **Level 4 Evaluation (Results)**: This level involves evaluating the interns' success rate in the SLLE administered by the SCFHS. The exam was conducted one year after the end of the SLLE Preparation Program.

Instruments

- **Interns' Perceptions Questionnaire**: An anonymous self-administered questionnaire was used to collect information about interns' perceptions of the SLLE preparation program. The questionnaire was adapted from a previous study and reviewed for content validity by medical education experts at FCMS [15]. It comprised two main sections: Section 1 evaluated workshop aspects (content, venue/resources, and overall satisfaction), while Section 2 focused on speaker performance and effectiveness. The tool included 11 closed-ended items rated on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree), with total scores ranging from 11 to 55. Additionally, three open-ended questions were included to gather qualitative feedback on the strengths, weaknesses, and areas for improvement in the SLLE preparation program.
- **Pre-test/post-test**: The test consisted of researcher-developed multiple-choice questions (MCQs) aligned with the SLLE blueprint. Each test comprised 30 questions, with the same set administered before and after each session to evaluate the knowledge gain. Scores ranged from 0 to 30, with no formal cut-off point applied. The content was reviewed by MLS faculty staff members, an Assessment Center representative at FCMS, and external subject matter experts to ensure alignment with exam standards and content accuracy.
- **Preceptor Feedback Questionnaire**: The self-administered anonymous questionnaire was adapted from a previous similar study and reviewed for content validity by a medical education expert at FCMS [16]. It comprised 14 items rated on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree) with total scores ranging from 14 to 70. While no formal cut-off point was applied, the tool was designed to capture perceived behavioral changes in interns following the SLLE preparation program.
- **SLLE Passing Rate**: The SCFHS License exam scores of MLS interns are collected directly from the interns and the official SCFHS platform.

Data analysis

Data were handled using IBM's SPSS version 28. Descriptive statistics, including frequencies and percentages, were employed to represent participants' demographic characteristics. Interns' pre-test and post-test scores were computed, along with the mean and standard deviation for each exam. A paired samples t-test was utilized to assess the difference in means between the pre-test and post-test scores of the SLLE preparation program. A p-value below 0.05 was considered statistically significant.

Thematic analysis was used to interpret qualitative data and generate themes and subthemes. The analysis began with a thorough review of responses, followed by compiling and cleaning the data to ensure consistency for familiarization with the information. A coding framework was developed manually based on this initial review, allowing us to categorize the responses into relevant themes. The responses were systematically coded according to this framework, with new codes added as necessary to capture emerging themes. We conducted a frequency analysis to identify the most common perceptions and suggestions among interns. By grouping the generated codes, themes were proposed, reviewed, and named. Finally, the themes and subthemes were presented and supported by respondents' quotes.

Ethical considerations

The study was approved by the Institutional Review Board at FCMS (IRB Approval Number: **309/IRB/2022**). Furthermore, participants were provided with an explanation of the study and gave informed consent before participating. They were assured of their right

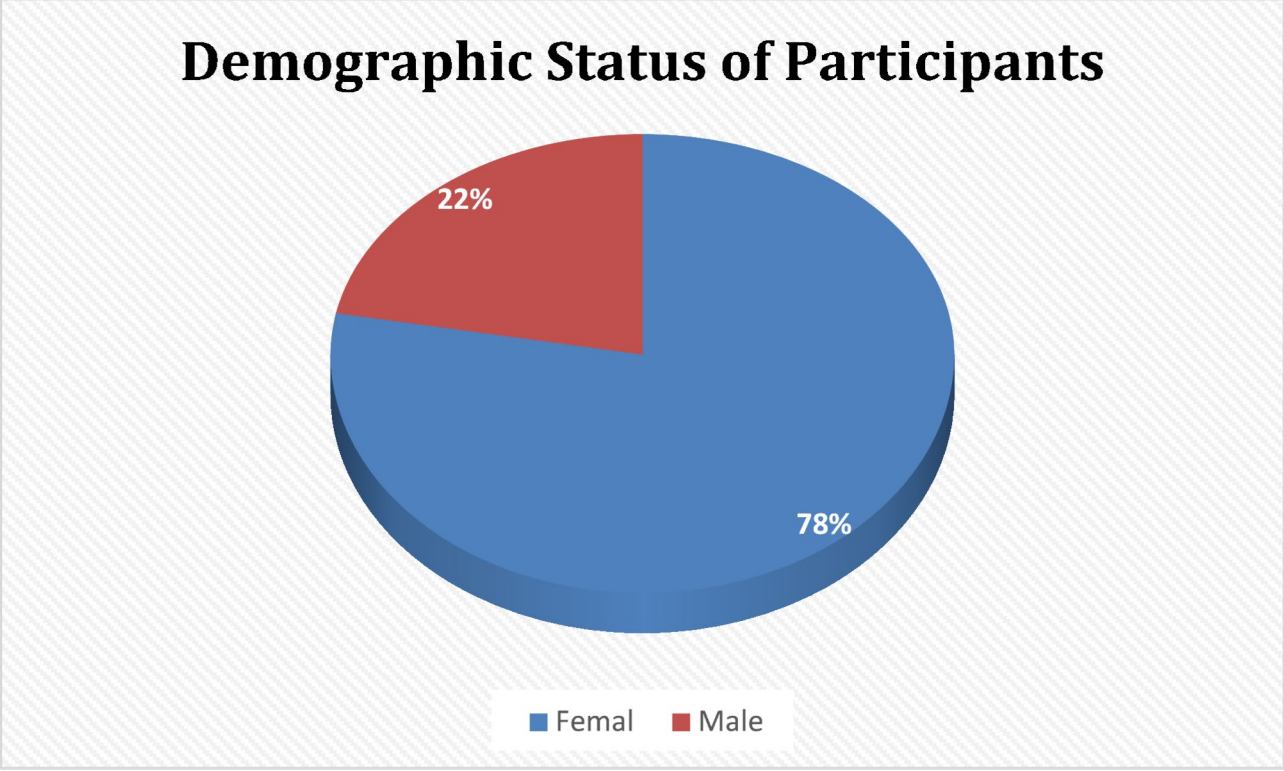

Fig. 1 Demographic status of participants

Table 1 Interns' satisfaction regarding the SLLE Preparation program

Workshop and speaker Evaluation forms	The content	The Venue and resources	The speaker	Overall
Blood Bank session	100%	98%	96%	98%
Hematology session	100%	98%	99%	99%
Immunology session	100%	100%	97%	99%
Microbiology session	94%	94%	100%	96%
Clinical Chemistry session	100%	98%	99%	99%
Urine Analysis and other Body Fluids session	94%	94%	100%	96%
Histo and Cyto Techniques session	100%	100%	100%	100%

to withdraw from the study at any time without consequences. To protect participants' privacy and confidentiality, all collected data were anonymized and securely stored on password-protected systems, accessible only to authorized research personnel. No personally identifiable information was included in the analysis or reporting of findings. Additionally, the data were used solely for research purposes and handled according to ethical guidelines.

Results

Demographic data of the study population (Descriptive)

All interns ($N = 18$) who joined the SLLE preparation program sessions agreed to participate in this study. There were 14 female interns, accounting for 78% of the participants, and 4 male interns, accounting for 22% of the total. (Fig. 1).

Kirkpatrick's Four-Level evaluation:

Level 1 evaluation (Reaction): descriptive

Table 1 provides insights into interns' satisfaction levels regarding various aspects of the SLLE preparation program, specifically focusing on workshop content, venue, resources, speaker effectiveness, and overall satisfaction. Throughout all sessions, interns generally reported high levels of satisfaction, with the majority of responses falling within the 94%–100% range. Notably, the sessions on Blood Bank, Hematology, Immunology, Clinical Chemistry, and Histo and Cyto Techniques garnered consistently high satisfaction ratings, ranging from 96% to 100% across all evaluation criteria.

However, the sessions on Microbiology and Urine Analysis and other Body Fluids had slightly lower satisfaction ratings, particularly in the content category, with 94% satisfaction reported. Despite these lower ratings in

Table 2 Interns' qualitative feedback on the SLLE Preparation program:

Themes	Subthemes	Quotes
Representation of content	• Comprehensive content coverage • Alignment with SLLE requirements. • Appropriate time allocation for major topics • In-depth exploration and understanding of content.	*"The program really offered a comprehensive and representative content coverage aligned with SLLE requirements".* *"I think this program should consider extending the duration of specific topics, such as Microbiology and Urine Analysis and other Body Fluids, to enable more in-depth exploration and understanding".*
Appropriateness of instructional approaches and teaching strategies	• Interactive teaching strategies. • Supporting audiovisual materials. • Effective audience engagement strategies. • Opportunities for active participation and discussion.	*"The program is based on many engaging and interactive teaching methods, which was an interesting and valuable experience".* *"The training included high-quality audiovisual materials that enhanced learning".* *"I believed that one of the most important aspects of this program's strengths is that presenters used approaches to engage the audience that I found effective".* *"We practiced a lot of discussions during the course of this program, that really captured the essence of active participation".*
Availability of resources.	• Training on SLLE format questions. • Developing an online platform for the SLLE preparation program. • Blended learning.	*"If I have to think about one point for improving this program, it would be providing additional practice questions mirroring the SLLE format."* *"It would be great to have an online platform that would aid for this program's effectiveness and value for continued access to resources post-program, allowing participants to revisit key content."* *"A blended learning model would be a good choice for this kind of training, combining both face-to-face and online sessions, to provide greater flexibility and reach."*

some areas, all sessions still maintained high overall satisfaction ratings, reflecting the overall effectiveness of the SLLE preparation program in meeting interns' needs and expectations.

Qualitative data derived from the three open-ended questions focused on the strengths, weaknesses, and areas for improvement of the SLLE preparation program; the three questions yielded 18 responses that reflected positive experiences and high levels of satisfaction among the participants. Data were organized, sorted, and coded to generate the following three themes: (1) Representation of content, (2) Appropriateness of instructional approaches and teaching strategies, and (3) Availability of resources, as shown in Table 2. Interns consistently highlighted several key strengths of the SLLE preparation program; many participants agreed that the program excelled in several aspects, from the content delivery to the interactive sessions, and that it truly prepared them for the SLLE. While most participants reported a few significant weaknesses, a few areas for improvement were identified. The predominant recommendation from participants was to allocate additional time to several fundamental topics, explore the possibility of providing online learning opportunities within the training course, offer an increased number of practice questions, and maintain the availability of this program for all future cohorts. A consensus among the majority of interns indicated that the program ought to be compulsory for every MLS student preparing for the actual SLLE, as it constitutes an invaluable resource. These qualitative insights validate the high satisfaction scores and highlight the perceived value of the SLLE preparation program among participants.

Table 3 Interns' learning regarding the SLLE preparation program

Session	Pre/Post test	Mean	SD	Sig
Blood Bank	Pre-test	8.6	4.5	0.000
	Post-test	15.7	7	
Hematology	Pre-test	9.4	4.7	0.001
	Post-test	16.5	7.3	
Immunology	Pre-test	12.1	5.7	0.001
	Post-test	18.7	7.7	
Microbiology	Pre-test	9	3.5	0.002
	Post-test	15.2	6.6	
Clinical Chemistry	Pre-test	12.7	4.1	0.002
	Post-test	17.8	5.2	
Urine Analysis and other Body Fluids	Pre-test	10.3	3.1	0.019
	Post-test	14.8	7	
Histo and Cyto Techniques	Pre-test	10.6	6.2	0.000
	Post-test	21.3	4.3	

Level 2 evaluation (Learning): analytical

Table 3 summarizes the pre-test and post-test exam scores for various subjects within the SLLE preparation program. The scores across these subjects in the SLLE preparation program indicate a consistent improvement in students' understanding following the sessions. However, noticeable variability exists in the degree of score increases among different subjects. The Histo and Cyto Techniques session demonstrated the most significant improvement, with post-test scores rising by 10.7 points (from 10.6 to 21.3). This suggests that the instructional approach for this subject was highly effective due to engaging teaching methods and practical applications. Blood Bank (7.1-point increase), Hematology (7.1), and Immunology (6.6) also showed substantial improvement. The statistically significant differences ($P < 0.001$ for all)

confirm the effectiveness of these sessions in enhancing students' knowledge.

Microbiology (6.2-point increase) and Clinical Chemistry (5.1) also exhibited notable gains, with P-values indicating significant learning progress ($P < 0.002$). However, Urine Analysis and Other Body Fluids experienced a minor improvement, with a 4.5-point increase (from 10.3 to 14.8). While still statistically significant ($P < 0.019$), this lower gain suggests challenges in content delivery and student engagement.

Level 3 evaluation (Behavior): descriptive

Table 4 shows high ratings across various domains, with scores reflecting positive perceptions averaging 4.6 out of 5.0. The highest-rated domain is Teamwork (4.8), highlighting collaboration, strong interpersonal relationships, and effective coordination among team members. The lowest-rated domains are Clinical Knowledge and Performance (4.5) and Communication (4.5). While these scores remain high, these areas could benefit from further enhancement.

Level 4 evaluation (Results): analytical

Figure 2 illustrates that all MLS interns who engaged in the SLLE preparation program successfully passed the SCFHS license exam on the first attempt (AY 2022–2023), exceeding the internal benchmark (AY 2021–2022) by 18%, which reflects performance before the implementation of the program. Moreover, the actual achievements exceed the target by 10%. This level involves evaluating the interns' success rate in the SLLE administered by SCFHS. The exam was conducted one year after the end of the SLLE Preparation Program. The data were collected from interns and the official SCFHS platform.

Table 4 Preceptor feedback about MLS interns' performance

Domains	Average*
Clinical Knowledge and Performance	4.5
Communication	4.5
Organizational Skills	4.6
Teamwork	4.8
Average	4.6

*five-point Likert response scales ranging from strongly disagree with a value of (1) to strongly agree with a value of (5)

Discussion

This study was innovative as the first of its kind in Saudi Arabia, specifically addressing the SCFHS qualification exams, notably the SLLE. This research has the potential to provide valuable insights into preparation programs aimed at enhancing the SCFHS licensure examination passing rates in other MLS colleges throughout Saudi Arabia.

The MLS program at FCMS reported a significant decline in first-attempt pass rates of the SLLE for the

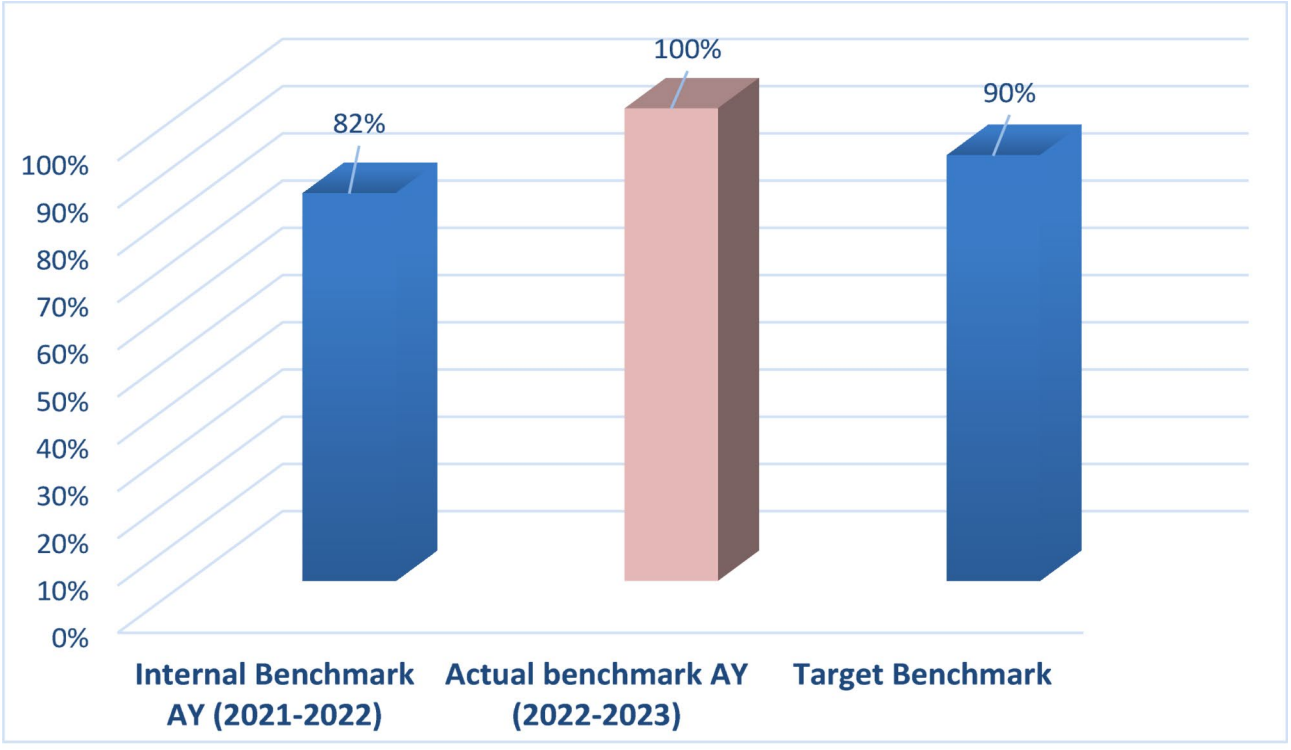

Fig. 2 Performance of MLS interns in the SCFHS examination

2021–2022 graduates, indicating a pressing need for improved exam readiness. To address this issue, this study aimed to develop, implement, and evaluate the SLLE preparation program for MLS interns at FCMS to enhance their knowledge and skills, ensuring a high probability of passing the SLLE on the first attempt. It was noted that few studies in Saudi Arabia support the efficacy of the preparation programs to improve interns' performance in the professional licensure examination. Many studies have shown the effectiveness of enrichment, remediation, comprehensive, or preparation programs in equipping students to pass their Licensure Examination successfully or identifying distinctive success predictors. However, most of these studies were conducted on nursing students [10, 13, 17–20]. Particularly, remediation and enrichment programs have been shown to improve students' performance on national licensure examinations through interactive teaching strategies and formative assessments [18, 21].

In this study, we evaluated our program according to the four levels of Kirkpatrick's Evaluation Model. **Level 1 (Reaction)**: This level measures interns' perception of the training program. The results revealed the high satisfaction ratings due to the comprehensive content, well-structured delivery, interaction of the speakers with the participants, and blend of interactive lectures and discussion of the subject provided during the sessions. This is supported by previous studies conducted by Brownie et al. (2015) and AlMekkawi et al. (2020). Both studies demonstrated that student nurses' academic performance improved as a result of utilizing interactive teaching strategies and incorporating formative assessments in remediation programs. In addition, instructors play a necessary role due to their direct influence on the teaching methods and content, and the identification of varied learning preferences and styles is important in education [12, 18].

The qualitative feedback from interns provided valuable insights into the strengths and areas for improvement in the SLLE preparation program. Interns appreciated the comprehensive content coverage and alignment with SLLE requirements, particularly praising the interactive teaching strategies and use of audiovisual materials that enhanced engagement and learning. However, some suggested extending the time allocated to complex topics such as Microbiology and Urine Analysis to promote deeper understanding. Additionally, interns expressed a desire for more practice questions in the SLLE format, access to an online platform, and a blended learning approach to increase flexibility and reinforce learning. These findings align with a recent study emphasizing the importance of tailored preparation strategies in improving licensure outcomes [11]. Overall, the qualitative data support the quantitative results, underscoring the program's effectiveness while offering direction for future enhancements.

Level 2 (Learning) This level involves assessing the extent of knowledge acquisition. The program significantly improved interns' knowledge across various subject areas, as demonstrated by a marked increase in post-test scores. For instance, the Histo and Cyto Techniques session showed the highest improvement, with a statistically significant increase of 10.7 marks ($P < 0.0001$). These results indicate the effectiveness of the SLLE preparation program in enhancing interns' knowledge in these areas. All instructors employed various teaching methods to enhance students' comprehension and critical thinking skills. These methods were applied during subject reviews and mock assessments that closely resembled the actual licensure examinations (SLLE) in the pre/post-test format. This approach is supported by previous studies, which indicated that remediation programs offering comprehensive reviews and practice exams identical to those used for licensure examinations can effectively assess students' readiness. In addition, it has also been shown to increase overall passing rates on actual licensure exams (Brownie et al., 2015). Collectively, overall program findings showed that students' performance was significantly improved after the delivery of the preparation program sessions in the post-test.

The current findings are also aligned with the results from the Alharbi study, which demonstrated that the Saudi Nursing Licence Exam (SNLE) enrichment program led to higher exam scores [13]. The findings of our current study indicated that all the sessions were beneficial to interns and improved interns' skills in test-taking and critical thinking. Furthermore, the increase in the post-test score may be attributed to the use of different teaching strategies during the session, including a systemic review of the subject, a blend of lecturing and interactive learning, and a discussion of the important concepts in the subject which have an obvious positive impact on the intern scores, and their critical thinking. These strategies enhanced problem-solving skills by fostering active engagement among knowledge, skills, and contemporary learning methodologies [22]. Nevertheless, to improve students' performance on licensure examinations, it is necessary to shift from the traditional to a more constructive approach [12].

Level 3 (Behavior) The impact of the SLLE preparation program extended beyond the exam itself. Preceptors reported high satisfaction with MLS interns' clinical performance, indicating that the knowledge gained during the preparation sessions translated into enhanced competency in clinical settings. This observation aligns with previous studies that emphasized the link between

educational interventions and improved clinical readiness among interns [23]. The structured integration of the SLLE preparation program with the internship training period may have further strengthened interns' practical skills and confidence.

Level 4 (Results) This level assesses the interns' success rate in the SLLE administered by the SCFHS. This exam was conducted one year after the end of the SLLE Preparation Program. The first-attempt SLLE pass rate for FCMS MLS interns increased to 100%. These findings support prior studies demonstrating the success of structured preparatory courses in national licensure exam outcomes [13].

While various external factors can influence students' performance on the SLLE, our analysis suggests that the SLLE preparation program has significantly improved outcomes. Individual differences, such as study habits, anxiety levels, and time management skills, can affect exam performance, but these factors are not unique to any one cohort. The clinical environment, including consistent resources and facilities at DSFH, remained stable across cohorts, although subtle variations in patient populations may have occurred. Additionally, the quality and experience of preceptors may have evolved, potentially benefiting the current cohort. Changes in exam structure or content could also have influenced outcomes, but recent SCFHS documents indicate relative stability in this area. Despite these potential external influences, the marked improvement in pass rates strongly suggests that the SLLE preparation program was a key driver of success [24].

While our study demonstrates the immediate effectiveness of the SLLE preparation program in improving exam pass rates, we recognize the importance of assessing long-term knowledge retention. Currently, our focus has been on the short-term impact of the program, particularly on first-attempt SLLE pass rates. However, follow-up assessments to measure the retention of knowledge over time are crucial for further refining the program and understanding its sustained impact. To support long-term evaluation, our institution has implemented several strategies beyond the scope of this study. These include annual post-licensure alumni questionnaires to assess application of knowledge in professional practice, as well as, annual workshops for alumni, which include pre- and post-assessments, are conducted to evaluate knowledge retention. Additionally, employer satisfaction surveys are annually distributed to gather feedback on graduates' performance. While these strategies provide valuable insights, they are outside the focus of the current research and may be explored in future studies.

The scalability and applicability of this program beyond FCMS are promising. The structured approach, combining comprehensive content review, interactive teaching methods, and mock assessments, can be adapted to other MLS programs across Saudi Arabia. However, implementation may require consideration of institution-specific factors such as resources and faculty expertise.

Limitations of the study: Lack of a control group, which may introduce biases when interpreting the direct impact of the SLLE preparation program. Additionally, while all eligible MLS interns participated, self-selection bias could still be a factor, as students with higher motivation or better study habits may have engaged more actively in the program, influencing their exam performance. Future studies should consider a comparative analysis with previous cohorts who did not receive this intervention. Collaboration with additional MLS colleges throughout Saudi Arabia is planned to yield robust results.

Conclusion

This study demonstrates the effectiveness of the SLLE preparation program for MLS interns at FCMS. The program's integration of comprehensive content review, interactive teaching methods, and mock assessments that mirror the actual SLLE significantly enhanced interns' knowledge and skills. This is evidenced by the marked improvement in post-test scores across all subject areas and the 100% first-attempt pass rate in the SCFHS license examination. Beyond test scores, the program's success is reflected in high satisfaction rates among interns and positive feedback from preceptors regarding clinical performance, suggesting its role in enhancing overall professional competence. While acknowledging potential external factors, the consistent improvement across multiple evaluation levels strongly indicates the program's pivotal role in intern success. This innovative approach serves as a model for other MLS programs in Saudi Arabia and could contribute to broader improvements in licensure examination outcomes and professional readiness. Future research should focus on assessing long-term knowledge retention, career progression, and the program's impact on professional practice. Additionally, studies with larger sample sizes and multi-center collaborations are needed to evaluate the scalability and adaptability of the program across diverse educational settings.

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

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Author contributions
A.M: Designed the research methodology, managed data collection, performed statistical analyses, contributed to the theoretical framework of the study, assisted with literature review and referencing. E.G: Assisted with the design of the research methodology, assisted with data analysis, contributed to the interpretation of results, wrote the initial draft of the manuscript, provided critical revisions and feedback on the manuscript draft and, reviewed and edited the manuscript, ensuring clarity and coherence.All authors have read and approved the final version of the manuscript.

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Data availability
The author confirms that all data generated or analysed during this study are included in this published article.

Declarations

Ethics approval and consent to participate
This study was approved by the Institutional Review Board at Fakeeh College for Medical Sciences (FCMS) (IRB Approval Number: 309/IRB/2022). Written informed consent was obtained from all individual participants included in the study.

Consent for publication
All authors have read and approved the final manuscript and consent to its publication.
"Not Applicable": This study does not involve any patients, identifying images, or personal or clinical details of participants".

Competing interests
The authors declare no competing interests.

Author details
[1]Medical Laboratory Sciences Department, MLS Program, Fakeeh College for Medical Sciences, Jeddah 21461, Saudi Arabia
[2]Medical Education Department, Faculty of Medicine, Suez Canal University, Ismailia, Egypt
[3]Medical Education Department, Fakeeh College for Medical Sciences, Jeddah 21461, Saudi Arabia

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