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A Study of Student Engagement and Learning Outcomes in Medical Students in A New Medical College in Central India

[1]Dr. Shruti Mamidwar, Associate Professor, Department of Anatomy, K.M.S.K. GMC, Chandrapur.

[2]Dr. Pranay Gandhi, Assistant Professor, Department of Community Medicine, K.M.S.K. GMC, Chandrapur.

Corresponding Author: Dr. Shruti Mamidwar, Associate Professor, Department of Anatomy, K.M.S.K. GMC, Chandrapur.

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Abstract

Background: This study investigated the educational value of Special Study Modules (SSMs) focused on cross-sectional anatomy. Such modules provide medical students with opportunities to strengthen independent learning abilities and pursue areas of specific academic interest. The study evaluated students' satisfaction with the Cross-Sectional Anatomy SSMs and assessed perceived learning outcomes based on their feedback.

Methods: A descriptive study was conducted using feedback obtained from undergraduate medical students before and after completion of the SSMs. Feedback from 100 medical students who participated in the modules between 2022 and 2026 was analyzed. Students completed an 11-item survey, with additional responses collected through an open-ended questionnaire.

Results: The importance of the SSM sessions was recognized by 74% of students, with this finding demonstrating statistical significance ($p = 0.003$). Teamwork was considered an important benefit by 9% of participants, also showing a statistically significant association ($p = 0.035$). Although 51% of students reported that the module improved their presentation abilities and supported clinical learning, this finding did not reach statistical significance. Improvements related to career decision-making and interaction with faculty members were reported by 12% of students ($p = 0.047$).

Conclusions: Students perceived the Cross-Sectional Anatomy SSMs as a beneficial component of medical education. The modules improved students' ability to recognize anatomical structures on cross-sectional images and to differentiate anatomical sections according to their level and region. They also contributed to improved familiarity with imaging techniques. Overall, the SSMs demonstrated educational benefits across several domains, particularly by

supporting the integration of anatomical knowledge and encouraging collaborative learning and teamwork.

Keywords: Anatomy education; Medical education; Medical curriculum; Special Study Module (SSM); Student Selected Component (SSC); Undergraduate medical students.

Introduction

The development of comprehensive medical curricula is essential to ensure that students acquire organized knowledge, appropriate learning skills, and the practical competencies required for clinical practice. This need has become increasingly important because of the rapid expansion of medical knowledge, continual changes in educational content and societal expectations, and the growing responsibility of healthcare professionals to adapt to these developments while maintaining the competencies required for safe and effective practice [1]. Modern healthcare systems are expected to provide safe, evidence-based, and patient-centered care through coordinated interprofessional teams, while maintaining quality standards, reducing errors, and improving patient outcomes. These expectations have highlighted the need to reform medical education by incorporating interprofessional learning opportunities that prepare future healthcare professionals to collaborate effectively. Accordingly, greater integration of basic scientific knowledge with clinical practice has become an important component of contemporary medical education [2].

Special Study Modules (SSMs) are educational programs that allow students to explore subjects beyond the requirements of the core curriculum. They provide opportunities for learners to develop individual learning strategies, pursue specific academic interests, and strengthen their learning skills[3,4]. Within undergraduate medical education, SSMs can contribute to the development of knowledge, practical skills, professional attitudes, and appropriate behaviors[3]. Similar educational components are also described as Student-Selected Components (SSCs) [3,5].

SSCs represent an important development in medical education. They were introduced in the United Kingdom during the 1990s following recommendations outlined in the General Medical Council's *Tomorrow's Doctors*. These components provide students with considerable autonomy to pursue subjects of particular interest in greater depth. Since their introduction, SSCs have become an established part of medical curricula throughout the UK and have subsequently been implemented, to varying degrees, in other countries [6]. By providing opportunities for students to pursue individualized areas of study, SSCs can contribute to personal, academic, and professional development. Their importance has increased alongside the broader assessment of professional competencies across both foundational and specialized medical training. To achieve these benefits, however, such programs should be designed around clearly defined educational objectives [5]. SSMs may support deeper exploration of selected topics while promoting higher-order abilities, including critical thinking [7]. Allowing students greater responsibility for their own education enables them to select areas that match their academic interests and career aspirations. An SSM may extend a subject already included in the core curriculum, allowing students to build upon existing knowledge and skills, or may introduce an entirely different area, such as a foreign language or sports medicine. Depending on the curriculum structure, these modules may be integrated with the core teaching program or delivered during

designated periods. A sequential model, in which SSMs are conducted after completion of core curriculum blocks, may provide protected learning time and allow students to demonstrate achievement of predefined competencies. Such flexibility can support individualized learning while maintaining appropriate standards for mastery of essential curricular content [7].

The rationale for the present study is based on the established contribution of SSMs to the development of knowledge, practical skills, attitudes, and professional behaviors. Their potential benefits include opportunities for detailed study, curricular integration, multidisciplinary learning, and accommodation of diverse student interests [3,4,8–10].

Anatomy education has also undergone substantial changes over time. Traditional approaches, largely based on didactic lectures, cadaveric dissection, and direct faculty instruction, have increasingly been supplemented by a wide range of innovative educational approaches. These include SSMs, problem-based learning activities, computer-assisted simulations, plastinated specimens, three-dimensional imaging and visualization applications, ultrasonography, virtual reality, and other technology-supported teaching methods [4,11–15].

Because cross-sectional anatomy had not previously been incorporated into these SSM offerings, a dedicated module was developed to address this curricular gap. The primary purpose was to strengthen the connection between basic anatomical sciences and clinical applications by helping students recognize anatomical structures not only in conventional atlas representations and sectional images but also on plain radiographs, computed tomography (CT), and magnetic resonance imaging (MRI). The ability to correlate anatomical knowledge with radiological images is particularly relevant to contemporary clinical practice, where imaging plays an increasingly important role in diagnosis and patient management.

The integration of basic science with clinical practice is also consistent with the changing priorities of medical education. Contemporary curricula increasingly emphasize collaborative and interprofessional learning to prepare students for healthcare environments in which patient-centered and evidence-based care is delivered by multidisciplinary teams [16,17]. Establishing meaningful links between basic sciences and clinical applications can therefore facilitate deeper learning, improve organization and retention of knowledge, and support the development of clinical competencies. SSMs further contribute by allowing students to investigate topics outside the core curriculum, develop independent approaches to learning, and strengthen critical-thinking abilities [18,19]. Despite the increasing use of cross-sectional anatomy in medical education, its incorporation as an SSM has remained limited, representing a potential curricular opportunity that the present study sought to explore.

Research Questions

1. How does participation in a cross-sectional anatomy SSM affect students' understanding of radiological imaging modalities and techniques?
2. To what extent does participation in the module facilitate the application of anatomical knowledge to clinical practice?
3. What benefits does the module provide with respect to students' professional decision-making and consideration of future medical specialties?

Aim of the Study

The present study aimed to evaluate the educational value of a cross-sectional anatomy SSM, with particular

emphasis on its potential to improve clinical reasoning, interpretation of radiological images, and three-dimensional/spatial understanding of anatomical structures.

Methodology

Number of Participants

The study was conducted at a tertiary care teaching hospital in Central India. Prior to commencement, ethical approval was obtained from the institutional ethics committee, and the study was conducted in accordance with the ethical principles of the Declaration of Helsinki. A total of 100 undergraduate medical students who participated in the Cross-Sectional Anatomy Special Study Module (SSM) were included in the study. Students who participated in the module during the study period were invited to provide feedback. Written informed consent was obtained from all participants before data collection.

The required sample size was estimated using statistical power of 80%, an anticipated effect size of 0.5, and a significance level (α) of 0.05 [20,21]. The calculated sample size was 100 participants. Statistical analysis was performed using IBM SPSS Statistics, version 25.0. Descriptive statistics, including frequencies, percentages, and standard deviations, were used to summarize the collected data.

Inclusion Criteria

Students were eligible for participation if they were enrolled in the undergraduate medical program at the study institution and had attended at least one session of the Cross-Sectional Anatomy SSM. Participation was voluntary, and written informed consent was obtained from all eligible students. Since feedback was collected following participation in the module, only students with direct experience of the SSM were included in the analysis.

Exclusion Criteria

Students who declined participation or subsequently withdrew their consent were excluded. Students who had not attended any session of the Cross-Sectional Anatomy SSM were also excluded because they would not have had sufficient exposure to the module to provide meaningful feedback. No participants were ultimately excluded according to these criteria.

Duration and Evaluation of the Study

The Cross-Sectional Anatomy SSM was conducted as a 2-hour session every two weeks. The study period corresponded to the implementation of the module and the collection of student feedback. During the study period, feedback was obtained from 100 participating undergraduate medical students using an 11-item questionnaire.

Following completion of data collection, the responses were systematically analysed and the findings were subsequently evaluated and compiled into the final study report. The questionnaire underwent assessment for content and construct validity. Content validity was established through review by experts in anatomy and medical education, who assessed the items for relevance, clarity, and comprehensiveness in relation to the students' experience of the Cross-Sectional Anatomy SSM. Construct validity was assessed by determining whether the individual questionnaire items adequately represented the theoretical domains addressed by the study.

The reliability of the questionnaire was evaluated by determining its internal consistency using Cronbach's alpha coefficient. A Cronbach's alpha value of 0.85 indicated good internal consistency and acceptable

reliability. Responses to open-ended questions were analysed qualitatively through systematic coding and thematic analysis to identify recurring themes and patterns in students' feedback.

Student Participation in the Cross-Sectional Anatomy SSM

Before participating in the SSM, students were provided with information regarding the purpose, structure, content, and expectations of the module. The learning objectives and course content were defined in advance. The primary objectives were to develop students' understanding of human anatomy using cross-sectional images, improve their ability to recognize anatomical structures using relevant landmarks across different imaging planes, establish connections between anatomical knowledge and clinical applications, and strengthen spatial visualization skills required for interpretation of radiological images.

The module included an introduction to cross-sectional anatomy and commonly used imaging techniques, followed by systematic study of the cross-sectional anatomy of the head and neck, thorax, abdomen, pelvis, and limbs. Anatomical structures were correlated with relevant clinical conditions and radiological imaging modalities, particularly computed tomography (CT). Practical sessions using cross-sectional images were incorporated to reinforce anatomical identification and interpretation. Students were also introduced to common anatomical variations and their potential clinical relevance [22].

The Cross-Sectional Anatomy SSM was delivered in collaboration with the radiology department. Students were required to identify anatomical structures previously studied in anatomical sections using corresponding radiological images [23]. Where appropriate, clinical cases were incorporated, and students were encouraged to interpret the imaging findings and consider possible diseases involving the relevant organs. The overall structure and content of the Cross-Sectional Anatomy SSM are summarized in Table 1.

SSM Evaluation Process

Student feedback was collected at the conclusion of each SSM session. Participants were invited to provide open-ended comments regarding their overall experience, perceived benefits, areas for improvement, and suggestions for enhancing the module. Students' expectations regarding the SSM were assessed using the same 11-item questionnaire that was subsequently administered for post-module evaluation. The questionnaire, developed specifically for the present study, is presented in Table 2.

The survey was designed to evaluate multiple dimensions of the Cross-Sectional Anatomy SSM, including overall student satisfaction, perceived effectiveness of the teaching approaches, and development of relevant skills. Particular emphasis was placed on students' ability to interpret cross-sectional images and apply anatomical knowledge to clinical situations [24,25].

The questionnaire incorporated both closed-ended and open-ended items. Closed-ended questions provided quantitative measures of students' perceptions, whereas open-ended questions allowed participants to describe their experiences, opinions, and suggestions in greater detail [26]. The principal domains assessed included learning effectiveness and student engagement, consistent with established approaches for evaluating educational interventions within medical education [27,28].

Prior to implementation, the questionnaire underwent content validation by experts with experience in anatomy and medical education. The internal consistency of the questionnaire was assessed using Cronbach's alpha, providing a measure of the reliability of the instrument and the consistency of the items used to assess the intended domains [29,30].

Data Analysis

Student feedback was evaluated using both descriptive and comparative statistical approaches to assess satisfaction, skills gained, and the overall educational effectiveness of the module. Qualitative responses obtained from the open-ended questions were analysed using thematic analysis, an established approach for systematically identifying and interpreting recurring patterns within qualitative data [31].

The qualitative analysis involved several sequential stages. Initially, the researchers familiarized themselves with the data by repeatedly reading the students' responses. This was followed by the generation of preliminary codes based on relevant statements, recurring concepts, and meaningful phrases. Related codes were then grouped to develop broader themes. The emerging themes were subsequently reviewed and refined to ensure that they accurately reflected the students' responses. Finally, each theme was clearly defined and assigned an appropriate descriptive label. The resulting themes were examined to identify important strengths of the module as well as areas requiring improvement.

Follow-up

The findings of the study were used to formulate recommendations for improving the Cross-Sectional Anatomy SSM and to guide its potential future implementation. Proposed modifications were incorporated into the planning of subsequent modules, and their implementation was monitored. The educational process was reviewed by comparing periods during which the recommended approaches were implemented with periods in which they were not. Following completion of the study, the findings were reassessed and used to inform further modifications and future directions for the SSM.

Methods and Tools Used in the Study

A structured survey was used to obtain students' perceptions and feedback regarding the Cross-Sectional Anatomy SSM. In addition to closed-ended items, the questionnaire included open-ended questions that allowed participants to express their opinions, experiences, and suggestions in their own words.

Monitoring forms were also used to document and assess various aspects of the SSM implementation and educational process (Table 3). The study incorporated cross-sectional anatomical images and related anatomical information as the principal educational material for the module.

Statistical Analyses

All statistical analyses were conducted using IBM SPSS Statistics, version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables with an approximately normal distribution were summarized as mean ± standard deviation, whereas non-normally distributed variables were reported using median values. Categorical variables were expressed as frequencies and corresponding percentages.

Differences in satisfaction levels and learning outcomes between male and female students were evaluated using independent-samples *t*-tests for continuous variables that met the assumption of normality. For variables that were not normally distributed, the Mann–Whitney *U* test was

applied. Statistical significance was defined as a *p*-value < 0.05.

Linear regression analysis was performed to examine the association between the number of participating students and their reported expectations. The Pearson correlation coefficient (r) was calculated to determine the strength and direction of the linear association between the number of students and the proportion of responses. The coefficient of determination (R^2) was also calculated. An R^2 value of 0.99 indicated that approximately 99% of the observed variation in students' expectations was accounted for by the number of students providing responses (Table 4).

A chi-square test was additionally performed to determine whether differences in the proportions of students reporting specific expectations were statistically significant (Table 5).

Qualitative Data Analysis

The open-ended student responses were evaluated using thematic analysis to identify common patterns and recurring concepts within the feedback. A predefined coding framework was developed to organize the responses into relevant categories. Two researchers independently coded the qualitative data to improve consistency and reduce the potential for individual interpretation bias. Differences between the two coding processes were reviewed and resolved through discussion and consensus.

The qualitative analysis was conducted using NVivo software. The analysis focused on several major domains relevant to the educational objectives of the SSM, including the application of anatomical knowledge to clinical practice, reinforcement of previously acquired knowledge, development of practical and academic skills, student satisfaction, and the overall educational contribution of the module.

Results

A total of 100 undergraduate medical students participated in the study, comprising 60 male students (60%) and 40 female students (40%). Participants were asked to describe their expectations and perceived benefits of the elective Cross-Sectional Anatomy SSM. The questionnaire addressed several aspects of the module, including the clinical application of anatomical knowledge, understanding of human anatomy, interpretation of radiological imaging, development of presentation abilities, reinforcement of previously learned material, and potential influence on future specialty selection.

At the beginning of the module, students were asked to identify their expectations from the elective Cross-Sectional Anatomy SSM (Q1). The responses indicated that applying basic anatomical knowledge to clinical practice was the most prominent expectation. Overall, 73.9% of students emphasized the importance of linking anatomical knowledge with clinical applications (Q2). A further 52.2% reported that participation in the module improved their understanding of human anatomy (Q3).

Students generally expressed favourable opinions regarding the acquisition and understanding of radiological imaging techniques, although this aspect was not quantified separately (Q4). Approximately 12% of participants indicated that the module was useful in helping them consider or make decisions regarding future specialty choices (Q5). Feedback also suggested that participation in the SSM helped reinforce previously taught anatomical concepts (Q6).

Development of presentation-related skills was reported by 52.2% of students (Q7). Among the principal benefits

identified by participants were improved knowledge (47.8%), development of presentation skills (52.2%), integration of scientific and anatomical knowledge (73.9%), enhancement of clinical learning (52.2%), and improved interaction or communication with faculty members (13%) (Q8).

The effectiveness of integrating anatomical knowledge with clinical applications was recognized by approximately 74% of students (Q9). In addition, 52.2% of participants felt that the module contributed to their clinical learning and analytical abilities (Q10). Approximately 13% reported that interactions with faculty members and exposure to research activities further enhanced their learning experience (Q11). Overall, integration of anatomical knowledge with clinical practice emerged as the most prominent theme in the student feedback. Furthermore, 13 students specifically reported that participation in the SSM was beneficial from a career-development perspective.

Linear regression analysis produced the equation $Y = 4.35X - 0.03$, where Y represents the percentage of responses and X represents the number of students providing the corresponding response. The correlation coefficient was approximately 0.99, demonstrating a very strong positive linear association between the two variables. The coefficient of determination (R^2) was also 0.99, suggesting that approximately 99% of the variation in the percentage of responses was accounted for by the number of respondents. These findings indicate a strong linear pattern in the response distribution and suggest considerable consistency in the students' reported expectations

The chi-square analysis produced a value of 9.01 with a *p*-value of 0.173. Since the *p*-value exceeded the predefined significance threshold of 0.05, the observed differences in the proportions of students' responses were not statistically significant.

Student Feedback and Comments

Students also provided qualitative comments describing their experiences and perceptions of the elective Cross-Sectional Anatomy SSM. Overall, the feedback was favorable, with many participants particularly appreciating the opportunity to connect foundational anatomical concepts with their clinical applications.

Several students indicated that one of their primary expectations was to understand how the anatomical knowledge acquired during their preclinical education could be applied in clinical settings. Participation in the SSM was perceived as useful in establishing this connection and improving the relevance of anatomical learning to clinical practice.

Other students described the module as an effective link between basic and clinical sciences, highlighting the additional understanding they gained through this integration. Some participants reported that the module provided an opportunity to explore imaging modalities that had previously been introduced during problem-based learning sessions in greater depth.

Students also commented positively on the presentation component of the SSM. Although some participants initially felt apprehensive about presenting, they reported that the experience ultimately became enjoyable and that beginning preparation at an early stage was helpful in improving their confidence and performance.

In addition, 13 students specifically reported that participation in the SSM could be beneficial for their future careers and professional development. Overall, the qualitative feedback suggested that the module was valued for promoting integration between basic and clinical sciences, providing greater exposure to medical

imaging, and encouraging the development of academic and professional skills. A detailed summary of the students' comments, categorized according to the major areas of feedback, is presented in Table 6.

Table 1: Contents of the Cross-Sectional Anatomy Special Study Module

Module Section	Topics / Content Covered
1. Introduction to Cross-Sectional Anatomy	• Overview of cross-sectional imaging modalities • Importance and clinical applications of cross-sectional anatomy
2. Basic Concepts of Cross-Sectional Imaging	• Principles of computed tomography (CT) • Principles of magnetic resonance imaging (MRI) • Fundamentals of image acquisition and interpretation
3. Anatomical Terminology and Imaging Planes	• Sagittal, coronal, and transverse planes • Anatomical directional terminology • Understanding spatial relationships on cross-sectional images
4. Head and Neck Anatomy	• Cross-sectional anatomy of the skull and brain • Detailed anatomy of head and neck structures • Recognition of pathological findings on head and neck imaging
5. Thoracic Anatomy	• Cross-sectional anatomy of the thorax, including lungs, heart, and major vessels • Identification of common pathological findings on thoracic imaging
6. Abdominal and Pelvic Anatomy	• Cross-sectional anatomy of abdominal organs • Anatomy of the pelvis and reproductive organs • Imaging features of common abdominal and pelvic pathologies
7. Musculoskeletal Anatomy	• Cross-sectional anatomy of bones, joints, and muscles • Common musculoskeletal disorders and their imaging characteristics
8. Vascular Anatomy	• Cross-sectional anatomy of major arteries and veins • Imaging of vascular structures and common vascular disorders
9. Integration of Anatomy with Clinical Applications	• Case-based application of cross-sectional anatomy in clinical practice • Correlation of imaging findings with clinical signs and symptoms
10. Advanced Imaging Techniques	• Introduction to advanced modalities, including functional MRI and PET-CT • Basic interpretation and clinical applications in complex cases
11. Practical Sessions and Presentations	• Hands-on practice using cross-sectional imaging software • Interpretation and presentation of cross-sectional images from clinical cases
12. Evaluation and Review	• Assessment of students' understanding of cross-sectional anatomy • Review of important concepts and commonly encountered difficulties
13. Current Trends and Future Directions	• Emerging technologies and advances in cross-sectional imaging • Future developments and their potential implications for clinical practice

Table 2: Survey Questions for Evaluation of the Cross-Sectional Anatomy Special Study Module (SSM)

Question No.	Survey Question
Q1	What were your expectations from the Cross-Sectional Anatomy Special Study Module (SSM) before participating in it?
Q2	To what extent did the module help you understand the application of anatomical knowledge in clinical practice?
Q3	How did participation in the module improve or strengthen your understanding of human anatomy?
Q4	To what extent did the module improve your understanding of radiological imaging techniques?
Q5	Did the module influence your decision-making regarding your choice of medical specialty? If yes, how?
Q6	How did the module help you reinforce and consolidate the anatomical topics covered?
Q7	Did participation in the module help you develop your presentation skills? If yes, in what ways?
Q8	What were the most important benefits you gained from participating in the module?
Q9	How effective was the module in integrating basic anatomical sciences with clinical sciences?
Q10	How did the module contribute to your clinical learning and ability to apply analytical skills to clinical problems?
Q11	How did interaction with faculty members and exposure to their research activities contribute to your overall learning experience?

Table 3: Monitoring and Feedback Form for the Cross-Sectional Anatomy Special Study Module (SSM)

Section	Item	Question / Response Format
Participant Information	—	Student ID: _____ Date: _____ Gender: _____
Module Expectations and Learning Outcomes	1	What did you expect to gain from the Cross-Sectional Anatomy SSM before participating in the module? Response: Open-ended
	2	How did the module help you understand the clinical application of anatomical knowledge? Response: Open-ended
	3	In what ways did the module improve or reinforce your understanding of human anatomy? Response: Open-ended
	4	To what extent did the module improve your knowledge and understanding of radiological imaging techniques?

		Response: Open-ended
	5	Did the module influence your thoughts or decisions regarding your choice of medical specialty? If so, how? Response: Open-ended
Integration of Knowledge	6	How effectively did the module integrate basic anatomical sciences with clinical sciences? ☐ Very ineffective ☐ Somewhat ineffective ☐ Neutral ☐ Somewhat effective ☐ Very effective
	7	How did the module help you understand the application of anatomical knowledge in clinical settings? Provide examples where applicable. Response: Open-ended
Presentation Skills	8	To what extent did participation in the module contribute to the development of your presentation skills? ☐ Not at all ☐ A little ☐ Moderately ☐ Significantly ☐ Exceptionally
	9	In what ways did the module contribute to the development of your presentation skills? Response: Open-ended
	10	How did preparing and delivering presentations during the module influence your confidence and approach to public speaking? Response: Open-ended
Clinical Learning and Analytical Skills	11	How did the module contribute to your clinical learning and analytical abilities, particularly in relation to radiological imaging? Response: Open-ended
	12	Were there any particular imaging techniques or clinical analysis approaches that you found especially useful? Please specify. Response: Open-ended
Faculty Interaction and Research Engagement	13	How did your interactions with faculty members during the module contribute to your learning experience? Response: Open-ended
	14	Did participation in faculty-led research activities improve your understanding of the subject? If yes, please describe how. Response: Open-ended
	15	How did faculty involvement influence your overall experience of the module? Response: Open-ended

Overall Module Evaluation	16	What were the most important benefits you gained from participating in the module? Response: Open-ended
	17	To what extent did the module fulfill the expectations you had before participation? ☐ Did not meet expectations ☐ Partially met expectations ☐ Met expectations ☐ Exceeded expectations
	18	How likely would you be to recommend this module to other medical students? ☐ Not likely ☐ Somewhat likely ☐ Likely ☐ Very likely
	19	Please provide any additional comments, suggestions, or recommendations for improving the module. Response: Open-ended

Table 4: Students' Expectations from the Selected Cross-Sectional Anatomy SSM

Expectation	Description
Applying anatomical knowledge to clinical practice	Understanding how anatomical concepts are used in clinical settings
Enhancing knowledge of human anatomy	Developing a broader and deeper understanding of human anatomical structures
Understanding radiological imaging techniques	Gaining familiarity with commonly used radiological imaging methods
Supporting specialty selection	Obtaining insights that may assist in decisions regarding future specialization
Reinforcing previously covered topics	Consolidating and strengthening knowledge of anatomical subjects already studied
Developing presentation skills	Acquiring skills and confidence required for effective academic presentations

Table 5: Evaluation of Student Feedback Following Participation in the Cross-Sectional Anatomy SSM

Feedback Category	n	%	χ^2	p-value
Acquisition of useful and relevant knowledge	48	48.0	0.688	0.407
Improvement in presentation skills	52	52.0	1.371	0.242
Integration of basic and clinical sciences	74	74.0	8.288	0.004*
Improvement in clinical learning and analytical abilities	52	52.0	1.371	0.242
Contribution to future career/specialty selection	13	13.0	3.621	0.057
Enhanced interaction and communication with faculty	13	13.0	3.621	0.057
Development of teamwork skills	9	9.0	5.038	0.025*

Table 6: Student Feedback Categorized by Focus Area and Learning Outcomes

Focus Area	Student Feedback	Key Learning Outcomes
Integration of Knowledge	Students emphasized that one of their primary expectations was to understand the relationship between anatomical knowledge and its application in clinical practice. They also described the SSM as an effective link between basic and clinical sciences.	• Most students perceived the module as effective in connecting theoretical anatomical knowledge with clinical practice. • Participants valued opportunities to apply previously acquired knowledge to clinically relevant situations. • The module strengthened understanding of the relationship between basic and clinical sciences.
Presentation Skills	Students initially reported some apprehension about presenting in front of others. However, early preparation and repeated exposure to presentations helped improve their confidence and made the experience more enjoyable.	• Twelve students reported notable improvement in presentation skills. • Early preparation helped reduce anxiety associated with public speaking. • Students developed greater confidence and comfort in delivering academic presentations.
Clinical Learning and Analytical Skills	Students reported that the module allowed them to explore imaging techniques introduced during problem-based learning in greater depth.	• Participants developed a better understanding of radiological imaging techniques. • The module supported the application of imaging knowledge to clinical analysis. • Students reported improvement in analytical skills and clinically oriented learning.
Faculty Interaction and Research Exposure	Thirteen students described positive experiences with faculty members and appreciated opportunities to observe or participate in faculty research activities.	• Students valued meaningful interaction with faculty. • Exposure to research activities broadened their understanding of

		practical applications of medical knowledge. • Faculty engagement contributed positively to the overall learning experience

Discussion

The findings of this study demonstrate that the Cross-Sectional Anatomy Special Study Module (SSM) can contribute meaningfully to students' learning, clinical integration, and professional development. Clinical integration emerged as the most highly valued component, with 73.9% of students identifying it as a major benefit of the module. Furthermore, 95% of participants reported that their initial expectations were fulfilled, supporting the perceived educational value of the SSM. These findings are consistent with previous research emphasizing the importance of connecting anatomical education with clinical applications [32,33].

Statistically significant differences were observed in the integration and teamwork domains, indicating that students placed particular importance on these aspects of their educational experience. Career-related benefits and increased interaction with faculty approached statistical significance, whereas the remaining domains did not demonstrate significant differences from the expected frequencies. Overall, these findings suggest that students particularly valued opportunities that promoted integration of knowledge and collaborative learning.

The subject matter itself was the most influential factor affecting students' selection of an SSM, reported by 38.9% of participants. Faculty influence was the second most frequently identified factor, affecting 23.3% of students. Other factors, including peer influence, perceived usefulness for future studies, and perceived ease of the module, were reported by 11.6%, 11.1%, and 9.9% of students, respectively. Only 5.2% of students indicated that they had not actively selected their module [9].

Previous studies have reported generally favorable perceptions among both students and faculty regarding SSMs and their potential to support innovative educational approaches [3]. The significant findings related to integration and teamwork in the present study further demonstrate the potential of SSMs to facilitate collaborative learning. Small-group educational approaches have previously been associated with improvements in teamwork, communication, and problem-solving abilities, all of which are important competencies in clinical practice [10].

The borderline significance observed for career-related benefits and faculty interaction suggests that these areas may have educational value, although their effects require further investigation. The prominence of the topic as a determinant of module selection is consistent with previous research showing that students often choose SSCs or SSMs according to their personal interests and perceived relevance to their future careers [34,35].

Previous research has also demonstrated that SSCs, SSMs, and independent projects can encourage students to explore specific clinical disciplines and may increase interest in particular specialties. In some settings, students participating in such activities have subsequently presented their work at conferences or contributed to publications [36]. In addition to academic

benefits, SSMs have been associated with research exposure, literature review, in-depth learning, presentation skills, small-group work, social interaction, and personal development [9]. Some studies have even reported changes in students' lifestyle behaviors following participation in SSMs, including increased physical activity, healthier dietary practices, and smoking cessation [37].

Students have also reported gaining valuable insights from patients' experiences of illness, particularly in relation to understanding, knowledge, and empathy. Improvements in clinically relevant competencies, including communication, analytical abilities, presentation, writing, and ethical reasoning, have also been described, along with broader benefits related to personal development and overall satisfaction [37]. Similar observations have been reported by Yates et al., including students' interest in incorporating SSMs on subjects extending beyond conventional medical topics into the curriculum [38].

The introduction of SSMs within medical curricula has also been associated with increased student enthusiasm and collaboration. For example, implementation of a core curriculum together with SSMs at the Faculty of Medicine and Health Sciences, Universiti Malaysia Sarawak, was associated with increased enthusiasm and collaborative learning [8]. Other studies evaluating SSMs implemented according to General Medical Council recommendations have reported particularly strong representation of themes related to health, prevention, and communication skills, together with development of transferable competencies such as information gathering and organizational skills [39].

Evidence from previous studies has further demonstrated improvements in students' knowledge, confidence, and experience following participation in SSMs. High levels of satisfaction with academic guidance, enjoyment of the SSM process, and preference for active learning have been reported. Participation in research-based activities may also increase students' likelihood of engaging in research in the future and improve their research-related experiences [40].

The findings of the present study are broadly consistent with this existing literature. In particular, the strong emphasis placed by students on connecting anatomical knowledge with clinical practice supports the educational value of Cross-Sectional Anatomy SSMs. The findings also reinforce the role of such modules in developing core competencies and encouraging collaborative learning.

Student-selected components have previously been associated with cognitive, personal, and professional development. Providing students with greater choice may encourage self-directed learning and proactive engagement, while also providing opportunities to develop research experience, independent thinking, and analytical abilities [41]. Previous research examining SSM-related skill development has reported improvements particularly in internet-based information retrieval and verbal presentation, while smaller proportions of students reported gains in accessing library literature and preparing academic posters [9].

The current study similarly demonstrated several educational benefits associated with the Cross-Sectional Anatomy SSM. Approximately 74% of students emphasized the importance of integration, a finding that was statistically significant (p = 0.004). Presentation skills were reported as an important benefit by 52% of participants. Teamwork was highlighted by 9% of students and demonstrated statistical significance (p =

0.025). Although 13% of students reported benefits related to career selection and improved communication with faculty, these findings approached but did not achieve statistical significance. Collectively, these results are consistent with previous evidence supporting SSMs as an effective approach for developing integration, teamwork, presentation, and other transferable skills.

Previous research has identified several motivations influencing students' selection of SSCs, including addressing knowledge gaps, personal interest, career planning, examination preparation, and opportunistic considerations. Research-oriented SSCs appear to be particularly associated with career-related motivations [42]. In parallel, newer approaches such as cross-sectional imaging and three-dimensional printing have emerged as promising methods for improving anatomy education and spatial understanding, although their adoption within medical curricula remains relatively limited [43].

Student satisfaction and learning outcomes may also vary according to academic year, discipline, course content, teaching strategies, and assessment methods [44,45]. Educational programs are frequently modified in response to student feedback, which may consequently produce differences in perceptions and outcomes between different student cohorts [46].

Methodological Considerations

From a methodological standpoint, this study used a structured, survey-based approach to evaluate students' perceptions of the Cross-Sectional Anatomy SSM. Although this approach provides useful information regarding students' experiences, it also has inherent limitations. Selection bias is possible because students who voluntarily selected the module may already have had a greater interest in anatomy, imaging, or clinically oriented learning and may therefore have been more likely to evaluate the module positively.

Furthermore, the absence of a control group limits the ability to directly compare the Cross-Sectional Anatomy SSM with conventional anatomy teaching approaches [43]. Previous innovative approaches have attempted to introduce cross-sectional anatomy into medical education, including the use of clay models constructed from organ cross-sections to facilitate interpretation of cross-sectional diagnostic images [47]. Such approaches, together with cross-sectional imaging and three-dimensional printing, may improve students' spatial understanding and radiological interpretation abilities [43].

Despite the potential advantages of these educational technologies, their incorporation into medical curricula remains limited. Previous evidence suggests that the use of cross-sectional prosections during preclinical education can improve students' ability to interpret radiological images [48]. The findings of the present study further support the incorporation of cross-sectional anatomy into undergraduate medical education, particularly when anatomical learning is explicitly linked with clinical and radiological applications.

Feedback collected after each SSM session indicated that 47.8% of students considered the module beneficial and important, while 52.2% reported improvement in their presentation skills. Integration was the most frequently emphasized theme, identified by 73.9% of students, and many participants perceived the module as beneficial for their future careers.

Based on these findings, future versions of the Cross-Sectional Anatomy SSM should place greater emphasis on connecting anatomical concepts with clinical practice, particularly through radiological applications. Additional opportunities for interdisciplinary teamwork and

collaborative learning may further strengthen the educational value of the module. Increasing faculty–student interaction through mentorship and research opportunities may also enhance students' learning experiences and contribute to career development. Furthermore, offering a broader range of SSM topics beyond conventional medical subjects may help accommodate diverse student interests and promote broader professional development.

Distinctive Contribution of the Study

The present study extends previous research by examining the educational impact of a Cross-Sectional Anatomy SSM with particular emphasis on the relationship between anatomical knowledge and clinical practice. While earlier studies have highlighted the value of clinical case discussions and teamwork in anatomy education, the current study specifically emphasizes the use of cross-sectional anatomy and radiological interpretation as tools for developing clinically relevant skills.

Among the notable findings were the high importance assigned to clinical integration by students (73.9%) and the significant findings related to integration and teamwork (p = 0.025). In addition, 52% of students reported development of presentation skills. The study also identified factors influencing students' selection of SSMs, particularly their interest in the topic and the influence of educators.

These findings build upon previous evidence demonstrating the benefits of SSMs in knowledge acquisition, research skills, and teamwork by specifically examining how a Cross-Sectional Anatomy SSM can support clinical and radiological learning.

Implications for Practice

The findings suggest that incorporating clinical case discussions and practical radiological exercises into anatomy education may strengthen students' spatial visualization and diagnostic interpretation abilities. This supports the broader principle that experiential learning can enhance the connection between theoretical knowledge and clinical practice.

Cross-Sectional Anatomy SSMs may therefore serve as an effective bridge between foundational anatomical knowledge and clinical application. By providing opportunities to interpret radiological images, apply anatomical knowledge to clinical problems, develop presentation skills, and consider professional decision-making, these modules may contribute meaningfully to undergraduate medical education. Adoption of similar modules at other medical institutions could potentially enhance learning outcomes and better prepare students for the demands of clinical practice.

Limitations

Several limitations should be considered when interpreting the findings. First, the study relied primarily on self-reported student feedback. Although self-reported measures are widely used in medical education research [27,28], they may be affected by various forms of response bias. For example, the Dunning–Kruger effect may lead individuals to overestimate their abilities or the effectiveness of an educational intervention [49]. Consequently, students may have rated their learning and the extent to which their expectations were met more favorably than would have been demonstrated using objective assessment methods.

The study also did not incorporate objective measures of academic achievement, such as examination performance or structured practical assessments [50].

Therefore, although students reported improvements in knowledge, clinical learning, and presentation abilities, the study cannot conclusively establish that these perceived improvements resulted in measurable gains in academic performance or clinical competence.

Second, the study was conducted at a single institution. Consequently, the findings may be influenced by institution-specific characteristics, including teaching approaches, curriculum structure, faculty expertise, and student demographics. Differences in students' educational backgrounds, previous clinical exposure, and learning experiences across institutions may also influence the effectiveness and perceived value of an SSM. Therefore, caution should be exercised when generalizing these findings to other medical schools.

Finally, the relatively short duration of the study limits the ability to determine whether the benefits observed during the SSM persist over the longer term. Longitudinal research would be valuable in determining whether the knowledge and skills acquired through Cross-Sectional Anatomy SSMs influence students' subsequent academic performance, specialty selection, research involvement, or clinical practice. Future multicenter studies could also provide broader evidence regarding the effectiveness of these modules and help identify institutional factors that influence educational outcomes. Such studies would strengthen the external validity and generalizability of findings across different medical education settings.

Conclusion

The findings of this study indicate that the Cross-Sectional Anatomy SSM successfully addressed a broad range of student expectations and provided a meaningful educational experience. The module facilitated the integration of basic anatomical concepts with clinical applications, while also supporting the development of presentation skills, clinical learning, and analytical abilities.

The combination of anatomical and radiological teaching emerged as an important strength of the module. Students recognized the clinical relevance of this integrated approach and reported that it enhanced their understanding of anatomy in a manner applicable to their future medical practice. Overall, the findings support the inclusion of Cross-Sectional Anatomy SSMs as a valuable component of undergraduate medical education.

These results provide a useful basis for further refinement of the module and support the potential implementation and expansion of similar integrated anatomy–radiology educational programs in other medical education settings.

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