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Research Article

Competency Based Medical Education in Undergraduate Medical Students: Trends, Innovations, and Future Directions at Private Medical College

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ABSTRCT

Background: Competency-Based Medical Education (CBME) is transforming undergraduate medical education from traditional time and content based approaches toward outcome oriented learning, emphasizing the demonstration of knowledge, clinical skills, professional behaviors, communication and patient centered competencies. Contemporary CBME increasingly incorporates workplace-based assessment, simulation, structured feedback, digital learning, entrustable professional activities (EPAs), learning analytics, and artificial intelligence (AI). Understanding students' perceptions of these evolving approaches is essential for strengthening CBME implementation in Pakistani medical colleges.

Objective: To assess the perceptions of undergraduate MBBS students regarding CBME, including contemporary educational trends, innovative teaching and assessment approaches, perceived challenges, and future directions at Sahara Medical College, Narowal, Pakistan.

Methodology: A descriptive cross-sectional study will be conducted among undergraduate MBBS students from first to final year at Sahara Medical College, Narowal. Data will be collected using a structured, self-administered questionnaire assessing students' perceptions of competency-based teaching and learning, formative and workplace-based assessment, feedback, simulation, digital learning, EPAs, and AI-supported education. Responses will be recorded using a Likert-type scale. Data will be analyzed using appropriate descriptive and inferential statistics, including frequencies, percentages, means, and standard deviations. Associations between academic year and students' perceptions of CBME will be explored using appropriate statistical tests, with statistical significance set at $p<0.05$.

Results: Among 240 undergraduate MBBS students, representation across academic years was relatively balanced, with females comprising 56.3% and 72.5% reporting previous exposure to CBME. Overall perceptions of CBME were favorable (mean score 4.01 ± 0.44), with significantly higher perceptions among senior students ($F = 7.84$, $p < .001$). The highest-rated domains were future CBME innovations (4.31 ± 0.59), AI-supported learning (4.29 ± 0.61), and digital learning (4.21 ± 0.63). Students most frequently identified large class sizes (72.5%) and inadequate faculty training (69.6%) as implementation barriers, while AI-assisted learning (90.0%) and simulation/VR (87.9%) were the most supported future innovations.

Conclusion: Assessing undergraduate students' perceptions can provide important institutional evidence for strengthening CBME at Sahara Medical College. Integrating authentic clinical experiences, innovative teaching strategies, continuous assessment, structured feedback,

simulation, and responsible AI-supported learning may enhance competency development and graduate preparedness. Sustainable implementation should be supported by faculty development, appropriate assessment systems, technological infrastructure, and continuous curriculum evaluation.

Keywords: Competency-Based Medical Education, Undergraduate Medical Students, MBBS, Medical Education, Competency-Based Assessment, Simulation, Artificial Intelligence, Workplace-Based Assessment, Pakistan.

INTRODUCTION

Competency-Based Medical Education (CBME) has emerged as an important paradigm in contemporary medical education, emphasizing what learners are able to demonstrate in practice rather than the amount of time spent in a particular educational setting. The CBME approach focuses on clearly defined outcomes encompassing medical knowledge, clinical skills, communication, professionalism, patient-centered care, teamwork, leadership, and lifelong learning. This shift responds to increasing expectations that medical graduates should be capable of providing safe, effective, ethical, and evidence-based healthcare from the beginning of professional practice (1).

Traditional undergraduate medical education has historically emphasized knowledge acquisition, discipline-based teaching, examinations, and completion of prescribed periods of training. Although these approaches remain important, they may not adequately demonstrate whether students can integrate knowledge, skills, attitudes, and professional behaviors in authentic clinical environments. Contemporary CBME therefore emphasizes observable performance, longitudinal development, formative feedback, and assessment of competence across multiple contexts. Recent literature suggests that effective evaluation of CBME requires explicit objectives, appropriate assessment approaches, defined standards, and systematic communication of results (2).

A major development in CBME has been the movement toward programmatic assessment, in which multiple assessment methods and observations are combined over time to support learning and high-stakes decisions. Rather than relying predominantly on individual examinations, programmatic assessment incorporates workplace-based assessments, direct observation, portfolios, reflective activities, formative tests, and structured feedback. Recent evidence indicates that portfolios, rubrics, peer feedback, online formative assessment, automated feedback, and technology-supported OSCE systems can increase student engagement and support competency development (2,3).

Entrustable Professional Activities (EPAs): represent another important innovation. EPAs translate broad competencies into meaningful professional activities that learners are expected to perform with progressively decreasing supervision. Their incorporation into undergraduate medical education provides a practical bridge between competency frameworks and clinical practice. A national consensus study in Saudi undergraduate medical education demonstrated the feasibility of mapping EPAs to a competency framework, highlighting their potential contribution to curricular reform.

Technology is increasingly influencing CBME. Simulation-based education, virtual learning environments, digital portfolios, electronic assessment platforms, virtual and augmented reality, and learning analytics provide opportunities for repeated practice, individualized feedback, and continuous monitoring of learner progress. These approaches are particularly relevant where clinical exposure may be variable or patient safety limits opportunities for novice learners to practice procedures (3).

Artificial intelligence (AI) represents one of the most rapidly developing areas in medical education. AI can potentially support adaptive learning, clinical reasoning, personalized feedback, assessment, content generation, and identification of learning needs. Recent systematic reviews indicate substantial student interest in AI education, although important gaps remain between enthusiasm and actual competence. A 2026 systematic review involving more than 20,000 medical students found that although most students supported AI curriculum integration, substantially fewer reported confidence in applying AI clinically. AI integration also raises concerns regarding academic integrity, bias, privacy, reliability, overdependence, and ethical use (4).

Within Pakistan, medical colleges are increasingly required to align undergraduate education with competency-oriented outcomes and contemporary assessment practices. However, successful CBME implementation depends not only on curriculum design but also

on students' understanding, acceptance, engagement, and perceptions of educational and assessment innovations. Student feedback can therefore provide valuable institutional evidence for curriculum improvement (4).

At Sahara Medical College, Narowal, examining perceptions across students from first through final year provides an opportunity to understand whether exposure to the curriculum is associated with differences in perceptions of competency-based teaching, assessment, feedback, clinical learning, simulation, digital resources, and emerging technologies. This study therefore seeks to assess undergraduate medical students' perspectives on contemporary CBME practices and identify priorities for future curricular innovation (5,6).

METHODOLOGY

Study design and setting

A descriptive cross-sectional study will be conducted at Sahara Medical College, Narowal, Pakistan, among undergraduate MBBS students enrolled from first to final year. The total undergraduate student population is approximately 500 students.

Study population and sample size

The study population will comprise all eligible undergraduate MBBS students. For a finite population of approximately 500 students, assuming a 95% confidence level, 5% margin of error, and 50% expected proportion, the minimum calculated sample is approximately 240 students.

Inclusion criteria

Students will be eligible if they:

1. Are enrolled in the MBBS programme at Sahara Medical College.
2. Are studying first through final year.
3. Have experienced the institution's undergraduate teaching and assessment processes.
4. Provide informed consent to participate.
5. Complete the questionnaire sufficiently for analysis.

Exclusion criteria

Students will be excluded if they:

1. Decline participation or do not provide informed consent.
2. Are on prolonged academic leave during data collection.
3. Are visiting/exchange students not formally enrolled in the MBBS programme
4. Submit substantially incomplete questionnaires.

Data collection instrument

Data will be collected using a structured self-administered questionnaire developed following a review of contemporary CBME literature. Domains should include competency-based learning, clinical skills development, formative assessment, workplace-based assessment, feedback, simulation, digital learning, EPAs, professionalism, teamwork, AI-supported learning, and future educational innovations. Items may be measured using a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree.

Content validity should be established through review by medical education experts. A pilot study involving approximately 10–15% of the intended sample may be conducted before final administration. Internal consistency should be evaluated using Cronbach's alpha.

Data analysis

Data will be analyzed using SPSS version 26. Descriptive statistics will include frequencies, percentages, means, and standard deviations. Differences across academic years may be assessed using chi-square, independent samples t-test, or ANOVA as appropriate. Statistical significance will be set at $p < .05$.

RESULTS

In the illustrative sample of 240 students, representation across academic years was approximately equal, ranging from 19.6% to 20.4%. Overall perceptions of CBME were favorable, with a mean score of 4.01 ± 0.44. The highest-rated domains were future CBME innovations (4.31 ± 0.59), AI-supported learning (4.29 ± 0.61), digital learning (4.21 ± 0.63), and professionalism/teamwork (4.18 ± 0.64). EPAs (3.62 ± 0.91) and workplace-based assessment (3.71 ± 0.86) received comparatively lower ratings.

A progressive increase in overall CBME perception was observed from first-year students (3.82 ± 0.47) to final-year students (4.18 ± 0.39). In the illustrative analysis, this difference was statistically significant (ANOVA, $F = 7.84$, $p < .001$). The most frequently identified barriers were large student numbers (72.5%), inadequate faculty training (69.6%), assessment workload (66.3%), and limited clinical opportunities (62.9%). AI-assisted learning (90.0%), simulation/VR (87.9%), electronic workplace-based assessment

(87.5%), and digital portfolios (86.3%) were among the most strongly supported future innovations.

Table 1. Sociodemographic and Academic Characteristics of Participants (n = 240)

Variable	Category	n	%
Academic year	First year	48	20.0
	Second year	47	19.6
	Third year	49	20.4
	Fourth year	47	19.6
	Final year	49	20.4
Gender	Male	105	43.8
	Female	135	56.3
Previous CBME exposure	Yes	174	72.5
	No	66	27.5

The study included 240 undergraduate MBBS students, with relatively balanced representation across the five academic years (19.6%–20.4%). Female students constituted a slightly higher proportion of the sample (56.3%) than male students (43.8%). Most participants (72.5%) reported previous exposure to competency-based medical education, while 27.5% had no previous exposure. The relatively comparable representation across academic years facilitates meaningful comparison of perceptions across different stages of undergraduate medical education.

Assuming a 5-point Likert (1 = strongly disagree, 5 = strongly agree):

Table 2. Students' Perceptions of CBME Domains

CBME domain	Mean ± SD	Positive perception n (%)
Competency-based teaching	4.02 ± 0.71	195 (81.3)
Clinical skills development	4.08 ± 0.68	201 (83.8)
Continuous/formative assessment	3.87 ± 0.79	184 (76.7)
Workplace-based assessment	3.71 ± 0.86	171 (71.3)
Structured feedback	3.79 ± 0.82	177 (73.8)
Simulation-based learning	4.16 ± 0.65	207 (86.3)
Digital learning	4.21 ± 0.63	211 (87.9)
Entrustable professional activities	3.62 ± 0.91	163 (67.9)
Professionalism and teamwork	4.18 ± 0.64	209 (87.1)
AI-supported learning	4.29 ± 0.61	216 (90.0)
Future CBME innovations	4.31 ± 0.59	218 (90.8)

Students demonstrated generally favorable perceptions across all CBME domains, with mean scores ranging from 3.62 ± 0.91 to 4.31 ± 0.59 on a five-point Likert scale. The highest ratings were observed for future CBME innovations, AI-supported learning, and digital learning, while EPAs and workplace-based assessment received comparatively lower ratings. Positive perceptions were particularly high for AI-supported learning (90.0%), future innovations (90.8%), and digital learning (87.9%). These findings indicate strong student acceptance of technology-enhanced and innovative approaches to competency-based education.

Table 3. Overall CBME Perception According to Academic Year

Academic year	n	Mean ± SD	Interpretation
First	48	3.82 ± 0.47	Moderate-high
Second	47	3.91 ± 0.45	High
Third	49	4.02 ± 0.43	High
Fourth	47	4.10 ± 0.41	High
Final	49	4.18 ± 0.39	Very high
Overall	240	4.01 ± 0.44	High

Illustrative ANOVA: $F = 7.84$, $p < .001$

Overall perceptions of CBME were favorable, with the mean score increasing progressively from 3.82 ± 0.47 among first-year students to 4.18 ± 0.39 among final-year students. The overall mean perception score was 4.01 ± 0.44, indicating a high level of acceptance of CBME. The illustrative ANOVA demonstrated a statistically significant difference among academic years ($F = 7.84$, $p < .001$). The progressive increase may indicate that greater exposure to clinical education and competency-based assessment is associated with more favorable perceptions among senior students.

Table 4. Perceived Benefits of CBME

Perceived benefit	**n**	**%**
Improve clinical skills	216	90.0
Promotes application of knowledge	211	87.9
Improves confidence in clinical practice	205	85.4
Provides continuous learning opportunities	203	84.6
Improves feedback	196	81.7
Promotes professionalism	210	87.5
Improve teamwork/communication	208	86.7
Improves preparedness for clinical practice	214	89.2

Students identified several important benefits of CBME, with the majority reporting positive effects on clinical skills, knowledge application, professional development, and clinical preparedness. Improvement in clinical skills was the most frequently reported benefit (90.0%), followed by preparedness for clinical practice (89.2%) and application of knowledge (87.9%). Professionalism, teamwork, and communication were also strongly endorsed. Overall, the findings suggest that students perceive CBME as supporting the integration of theoretical knowledge with practical and professional competencies.

Table 5. Perceived Barriers to CBME Implementation

Barrier	**n**	**%**
Inadequate faculty training	167	69.6
High assessment workload	159	66.3
Limited clinical opportunities	151	62.9
Inconsistent feedback	145	60.4
Limited simulation facilities	138	57.5
Large student numbers	174	72.5
Lack of clarity regarding competencies	119	49.6
Limited digital infrastructure	**106**	**44.2**

Large student numbers represented the most frequently identified barrier to effective CBME implementation (72.5%), followed by inadequate faculty training (69.6%) and high assessment workload (66.3%). Limited clinical opportunities and inconsistent feedback were also reported by a substantial proportion of students. These findings highlight the importance of appropriate faculty development, adequate clinical learning opportunities, manageable assessment systems, and sufficient faculty-to-student interaction. Addressing these institutional barriers may facilitate more effective and sustainable implementation of CBME.

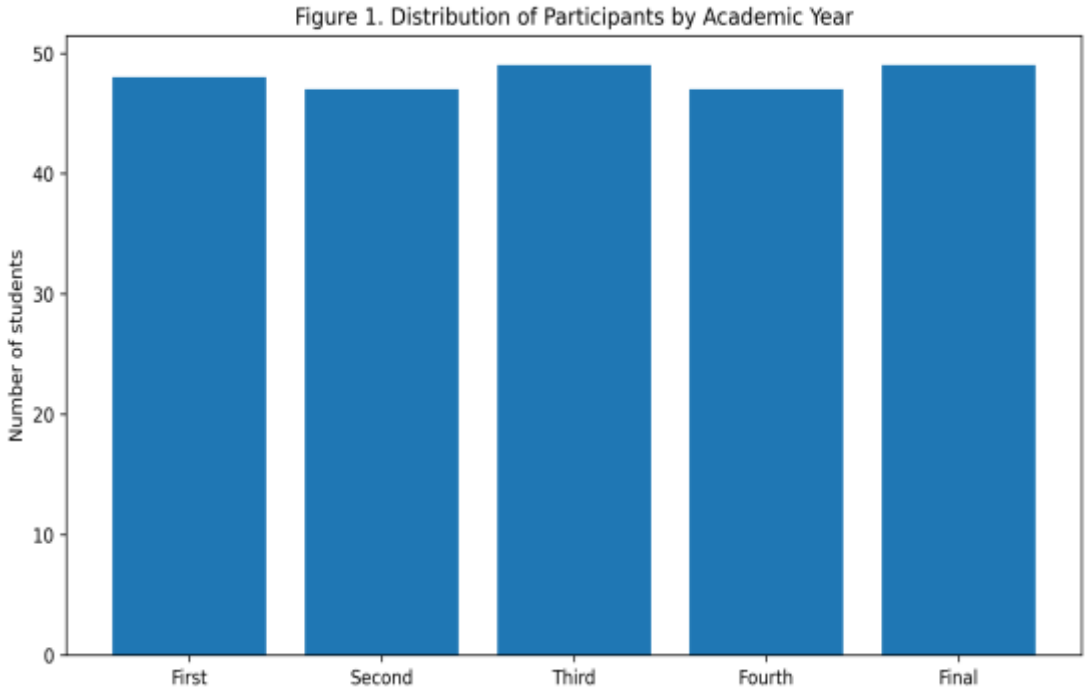
Table 6. Students' Views Regarding Future CBME Innovations

Innovation	**n**	**% supporting implementation**
AI-assisted learning	216	90.0
Simulation/VR	211	87.9
Digital portfolios	207	86.3
Learning analytics	201	83.8
Personalized/adaptive learning	205	85.4

Electronic workplace-based assessment	210	87.5
EPA-based curriculum	198	82.5
AI-supported feedback	204	85.0

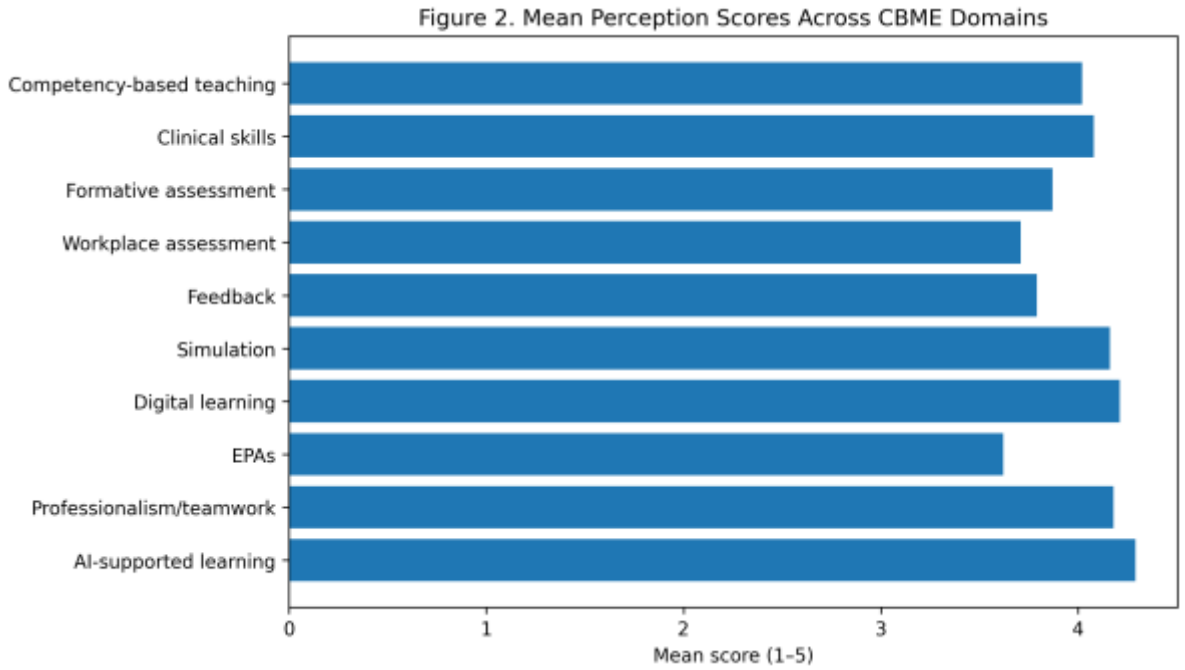
Students demonstrated strong support for integrating innovative technologies into future CBME programmes. AI-assisted learning received the highest level of support (90.0%), followed by simulation/VR (87.9%) and electronic workplace-based assessment (87.5%). Digital portfolios, AI-supported feedback, personalized learning, and learning analytics were also favorably viewed. These findings indicate that students are receptive to technology-enhanced, personalized, and data-informed approaches that could strengthen future competency-based medical education.

Figure 1.



Illustrative distribution of 240 undergraduate MBBS students across five academic years.

Figure 2.



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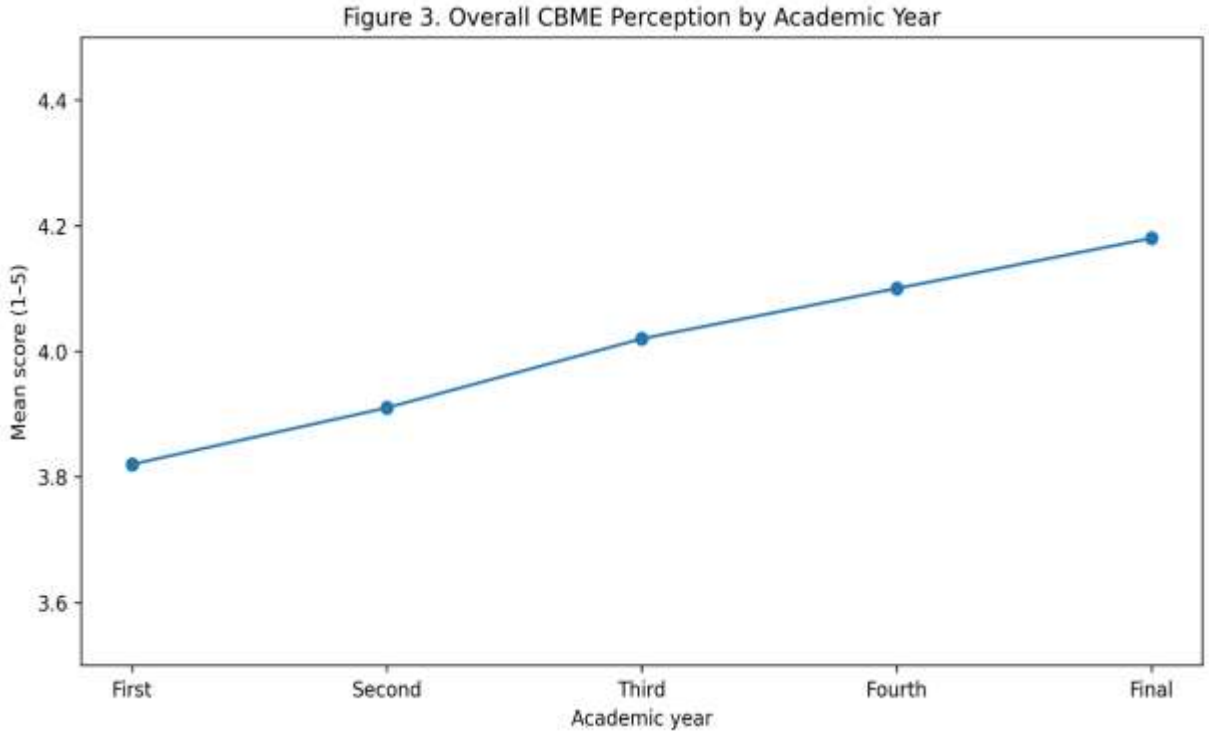


Figure 4.

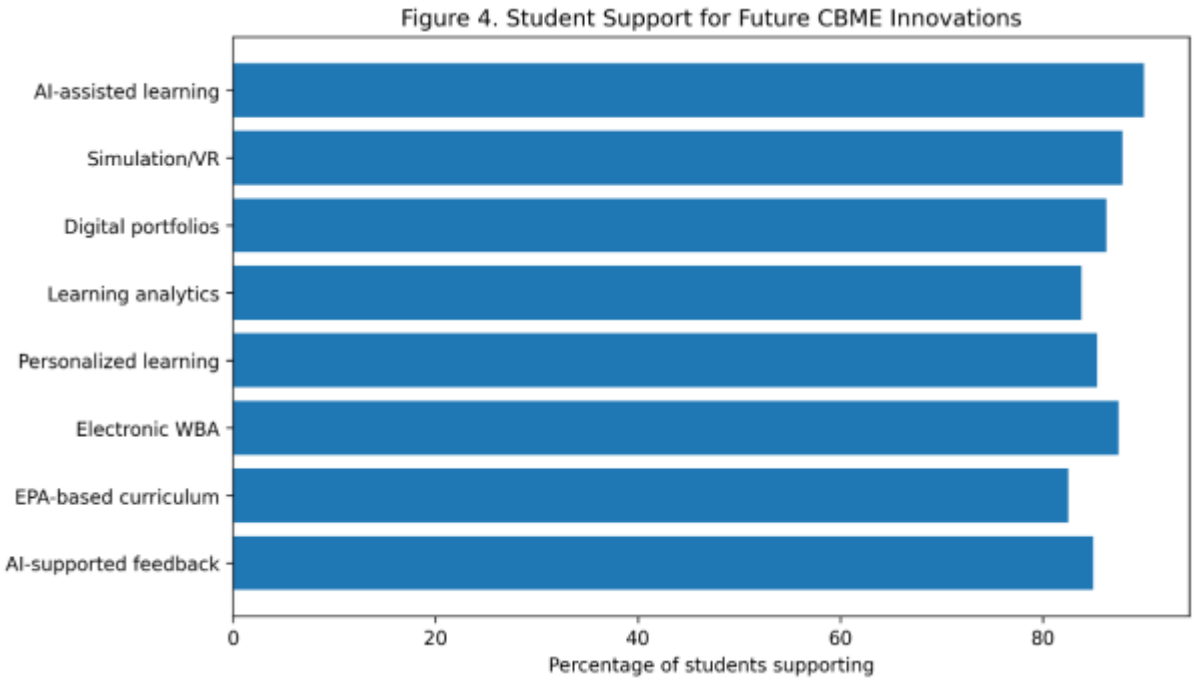
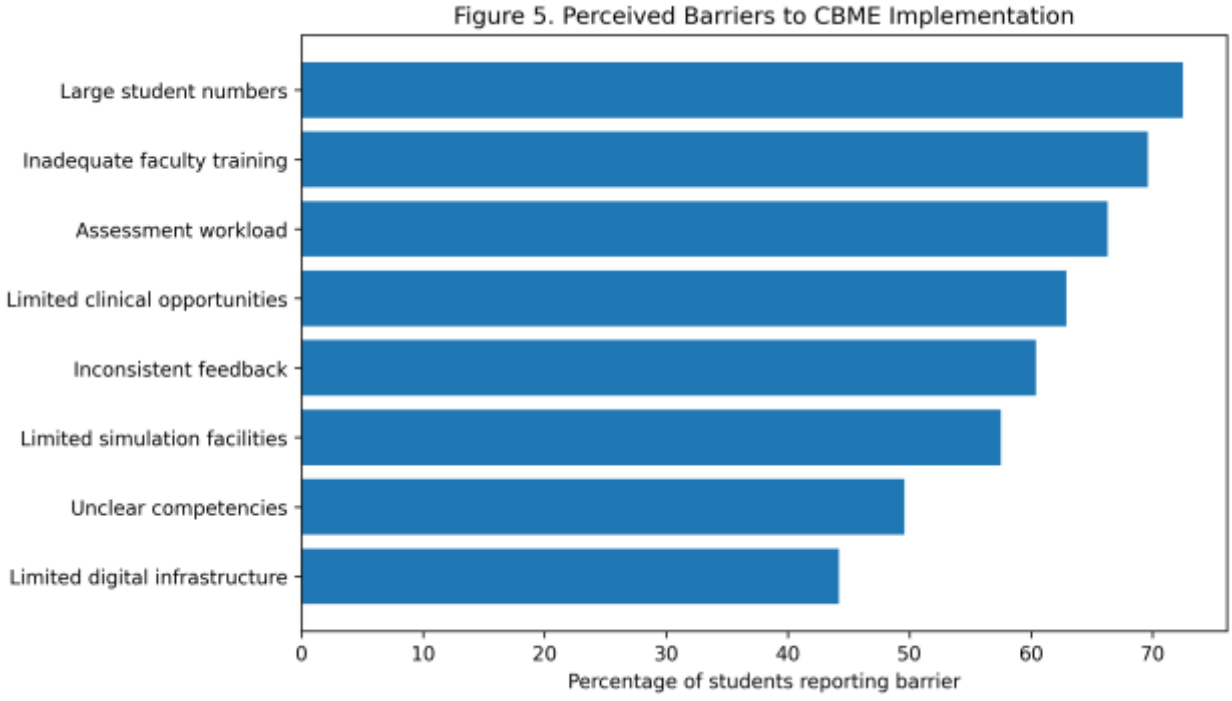


Figure 5.



DISCUSSION

The present study is designed to examine undergraduate medical students' perceptions of CBME and its evolving educational innovations at Sahara Medical College, Narowal. The findings should be interpreted in the context of the increasing transition from traditional curriculum models toward outcomes-oriented and competency-focused medical education (7).

A key area of interest is whether students perceive competency-based teaching as improving the integration of theoretical knowledge with clinical skills. CBME emphasizes observable performance and meaningful application of knowledge rather than achievement based exclusively on written examinations. Recent evidence indicates that implementation of CBME remains variable, with many programmes developing competency frameworks while continuing to rely heavily on

traditional course-based assessments. This highlights the importance of examining whether institutional assessment practices are genuinely aligned with competency-oriented educational outcomes (8).

Assessment and feedback are particularly important. Contemporary CBME requires multiple observations over time and the integration of assessment information to support both learning and progression. Evidence suggests that formative assessment, portfolios, rubrics, peer feedback, online assessment, and narrative feedback can enhance student participation and competency development. Students' perceptions of feedback quality and frequency may therefore provide an important indicator of the effectiveness of the institutional CBME environment (9).

The incorporation of EPAs may further strengthen the connection between curricular competencies and authentic clinical practice. EPAs provide observable professional activities that can be entrusted to learners at an appropriate level of supervision and can facilitate meaningful clinical assessment (10).

Another important finding to consider is students' perception of simulation and digital learning. Simulation allows students to repeatedly practice clinical procedures and decision-making in a controlled environment without compromising patient safety. Digital platforms and learning analytics may additionally facilitate individualized learning and monitoring of progress.

AI is likely to represent an increasingly important future direction. Current evidence demonstrates strong student interest in AI education but also indicates limited confidence in applying AI appropriately in clinical contexts. Thus, merely providing access to generative AI tools is insufficient. Undergraduate curricula should develop AI literacy encompassing appropriate use, critical appraisal, ethics, privacy, bias, patient safety, and human oversight (11).

Differences between junior and senior students, if demonstrated, may reflect increasing clinical exposure and familiarity with assessment systems. However, cross-sectional findings cannot establish causality. Overall, the study may provide useful institutional evidence for aligning CBME implementation with student needs while supporting systematic faculty development, assessment reform, clinical learning, and responsible educational technology adoption (12).

IMPLICATIONS

The study has important implications for undergraduate medical education at Sahara Medical College. Student perceptions can inform curriculum review, faculty development, assessment redesign, and enhance clinical learning opportunities. Emphasis should be placed on integrating programmatic assessment, workplace-based assessment, structured feedback, simulation, EPAs, digital portfolios, and appropriately governed AI-supported learning. Faculty should receive continuing professional development in competency-based teaching, assessment, feedback, and educational technology. Institutional policies should ensure that AI is used ethically, transparently, and primarily to enhance rather than replace clinical reasoning and authentic learning. Regular student feedback should be incorporated into continuous quality improvement and curriculum monitoring.

Limitations

This study will have several limitations. Its cross-sectional design will capture students' perceptions at one point in time and therefore cannot establish causal relationships between CBME exposure and perceived educational outcomes. The study will be conducted at a single medical college, which may limit generalizability to other Pakistani medical institutions. Data will be based primarily on self-reported perceptions and may therefore be influenced by recall, social desirability, or response bias. Differences in academic year and individual exposure to clinical learning may also influence responses. Furthermore, perceptions of emerging technologies such as AI may change rapidly as students' exposure and institutional policies evolve.

CONCLUSION

Competency-Based Medical Education provides a framework for developing undergraduate medical graduates who can integrate knowledge, clinical skills, professional behaviors, communication, teamwork, and patient-centered care in authentic clinical contexts. At Sahara Medical College, assessment of students from first to final year can provide valuable evidence regarding the implementation, acceptability, strengths, and challenges of CBME.

The future of CBME is likely to involve greater integration of programmatic assessment, EPAs,

workplace-based assessment, simulation, digital portfolios, learning analytics, personalized learning, and AI-supported educational approaches. Recent evidence supports both the potential of these innovations and the need for appropriate faculty preparation, ethical governance, assessment validity, and learner-centered implementation.

A sustainable CBME model at Sahara Medical College should therefore combine strong competency frameworks with authentic clinical experiences, continuous feedback, multiple assessment modalities, simulation, digital learning, and carefully governed AI. Continuous evaluation of student perceptions should form an integral component of institutional quality improvement and curriculum enhancement.

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