

Bridging Gaps in Teaching and Learning Biochemistry: A Qualitative Study

Syed Danish Haseen Ahmed, Ambreen Usmani*

Department of Biochemistry/Dow Medical College Karachi Pakistan, *Department of Health Sciences/
Bahria University of Medical & Dental College, Karachi Pakistan

ABSTRACT

Objective: To identify the sources of learning gaps in biochemistry teaching and learning and explore new teaching and learning strategies, considering the students' perceptions and felt needs.

Study Design: Exploratory qualitative study (Social-constructivist philosophical worldview).

Place and Duration of Study: Public Sector Medical College, Pakistan, from Jul 2020 to Jul 2021.

Methodology: Students from all five years of medical college were recruited voluntarily after their written consent. Ten focus group discussions were conducted, each consisting of approximately 8 to 12 participants. Each session was recorded and then later transcribed verbatim. Verbatim FGDs were reviewed, and codes were given as the concept became recognizable. A code structure was developed via an inductive approach, and then sub-themes and themes were generated.

Results: Ten major themes were generated from the FGDs. These themes were teaching, students' motivation, clinical irrelevance, educational needs, transition difficulty, attitudes, student support, senior peers, curriculum coherence, and assessment. These themes were further elucidated to explain the causes of the learning gaps and provide suggestions.

Conclusion: This study concludes that teaching, students' motivation, clinical irrelevance, educational needs, difficulty in transition, student attitude, student support, senior peers, curriculum coherence, and assessment are the potential sources of the learning gap to achieve intended learning outcomes of biochemistry for medical students.

Keywords: Biochemistry, Learning, Teaching, Medical education, Qualitative research, Biological sciences.

How to Cite This Article: Ahmed SDH, Usmani A. Bridging Gaps in Teaching and Learning Biochemistry: A Qualitative Study. *Pak Armed Forces Med J* 2024; 74(2): 522-529. DOI: <https://doi.org/10.51253/pafmj.v74i2.9994>

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by-nc/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

INTRODUCTION

Biochemistry is one of the key subjects taught in the pre-clinical years and requires special attention and needs. Biochemistry includes molecular chemistries, intriguing metabolism, genetics and complicated concepts that form the basis of diagnoses and treatment.¹ Globally, biochemistry faculty believe that a gap exists between already formulated learning objectives in the curriculum and what students are expected to receive and apply in their clinical sciences.^{2,3} To address this problem and keep students abreast with basic medical concepts, quality information, and their relevance to clinical sciences, educational research is necessary to understand these problems.⁴

Previously done studies for other medical specialties residency programs have successfully identified perceived challenges, felt needs, and several learning gaps that would be used for improving students' learning outcomes.^{5,6} A needs assessment study for "medical biochemistry practical" has found strengths/weaknesses of the biochemistry practical curriculum and pointed improvements.^{7,8} A previous study that explored the students' perceptions regarding

instructional methods and difficulties in understanding topics in biochemistry suggested that the teaching-learning process can be enhanced by understanding students' perceptions.⁹ To date, no comprehensive study can translate students' perceptions and felt needs for "medical biochemistry" into a meaningful learning-teaching environment.¹⁰

Medical biochemistry is a subject that explores the human body deep inside. It requires a lot of concept building, correlations, and lateral thinking that students find difficult. The purpose of this study is to identify the potential sources of learning gaps to achieve learning outcomes in biochemistry for medical students. It will also explore new teaching and learning strategies, considering the students' perceptions and felt needs.

METHODOLOGY

The exploratory qualitative study was conducted at a Public Sector Medical College, Pakistan, from July 2020 to July 2021, after approval by the Institutional Review Board, Dow University of Health Sciences (No: IRB-1708/DUHS/APPROVAL/2020/96).

Inclusion Criteria: Students from all five years of medical college were recruited voluntarily after their written consent.

Correspondence: Dr Syed Danish Haseen Ahmed, Department of Biochemistry, Dow Medical College, Karachi Pakistan
Received: 01 Mar 2023 revision received: 09 Apr 2023; accepted: 17 Apr 2023

Exclusion Criteria: None

Using a social-constructivist philosophical world view,^{11,12} different phenomena related to biochemistry teaching and learning were identified among the students (Figure). In total, we conducted 10 Focus group discussions. Each group consisted of approximately 8 to 12 participants. The number of focus group sessions exceeded the saturation point, with repeated themes and no new information. Two FGDs from the first year (FGDa-1, FGDa-2), two from the second year (FGDb-1, FGDb-2), two from the third year (FGDc-1, FGDc-2), two from the fourth year (FGDd-1, FGDd-2) and two from the final year (FGDe-1, FGDe-2). Purposive sampling was utilized to achieve meaningful results.

Microsoft Word 2022. Later, through repeated iteration and data familiarisation, some codes were discarded, and some were revised to interpret the themes.

Several steps were taken to ensure the internal validity of the data analysis. Data was presented to participants to verify the reality and meanings of the generated codes and themes. The researcher also confirmed similar phenomena by observing teaching sessions and analyzing documents like curriculum, assessment papers, and meeting minutes of the departmental board of studies.

RESULTS

A total of 10 focus group discussions of students from the first year to the fifth year were conducted in approximately 60 to 90 minutes. The demographic

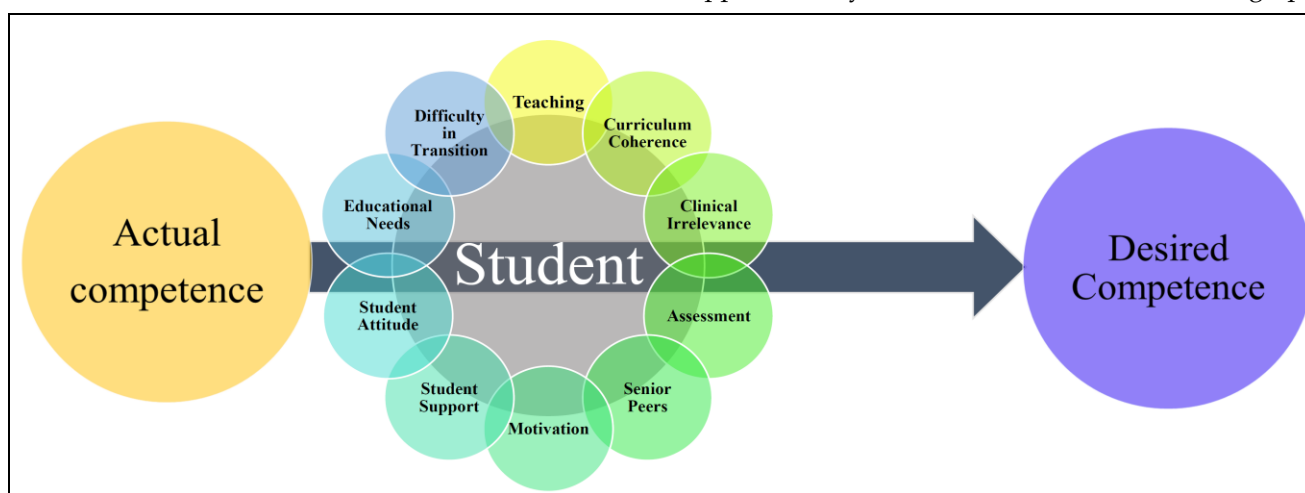


Figure: Conceptual Framework: Challenges faced by the Students to achieve desired Competence in the Study

Data was collected through Focus group discussion using the FGD outline, which was prepared following the steps explained by Krueger *et al.*¹³ Students' experiences, attitudes, and suggestions from all five years were explored. Each session was recorded and then later transcribed verbatim.

Data was analyzed using Braun and Clarke's six-phase approach for reflexive thematic analysis to answer the research questions.¹⁴ Verbatim FGDs were reviewed, and codes were given as the concept became recognizable. Due to the exploratory nature of the study, an inductive approach was used to develop a code structure purely reflecting the participant's experiences, and then later, sub-themes and themes were generated that were appropriate to the research questions and literature search. Preliminary coding was performed using the comments function in

distribution of participants is presented in Table-I.

Table-I: Demographic Distribution of Participants (n=102)

FGDs group	Year	Male (n) %	Female (n) %	Total (n) %
FGDa-1	1st	(6)60%	(4)40%	(10)9.80%
FGDa-2	1st	(5)42%	(7)58%	(12)11.76%
FGDb-1	2nd	(6)50%	(6)50%	(12)11.76%
FGDb-2	2nd	(3)33%	(6)67%	(9)8.82%
FGDc-1	3rd	(4)44%	(5)56%	(9)8.82%
FGDc-2	3rd	(6)54%	(5)46%	(11)10.78%
FGDd-1	4th	(7)58%	(5)42%	(12)11.76%
FGDd-2	4th	(6)60%	(4)40%	(10)9.80%
FGDe-1	5th	(5)56%	(4)44%	(9)8.82%
FGDe-2	5th	(3)38%	(5)62%	(8)7.84%
-	-	(51)50%	(51)50%	102

The themes generated from the FGDs are summarized in Table-II and explained in detail below:

Bridging Gaps in Teaching and Learning

Table-II: Summary of Themes and Sub-Themes from Focus Group Discussions

S. No.	Themes	Sub-Themes	S. No.	Themes	Sub-Themes
1.	Teaching	Preparedness knowledgeable Discussion Enthusiasm Effort Skill	6.	Students' Attitude	Apathy Undervalue teacher's respect Detachment Stereotyping
2.	Students' Motivation	enjoyment Interest Valuing teaching satisfaction	7.	Student Support	Feedback spiritual guidance. Student-teacher relation career counselling career options
3.	Clinical Irrelevance	Recognition importance real life mindless memorization knowledge application	8.	Senior Peers	Peer guidance Negative opinion Disinformation student's perspective
4.	Educational Needs	Modern Teaching style online resources learning trends self-study	9.	Curriculum coherence	Organization Missing topics Alignment Teaching methods Cognitive overload practical content experiential learning
5.	Difficulty in transition	Challenging environment Large class Different teaching style Unsupervised	10.	Assessment	Formative assessments Summative assessments Item-construction Alignment with objectives. Repetition case-oriented questions MCQ repository

Theme-1: Teaching: This is the most recurring theme. Most of the participants complained about the teachers' teaching style. Senior students particularly highlighted that teachers do not care about students' comprehension but rather try to complete the topic in a given time by merely reading the slides.

"Many teachers! I'm sorry to say that they are reading slides, and it feels like they have not come prepared with a lecture."

(FGDa-2) "They do not care if the students have understood the topic clearly; they just come into the class, not all the teachers but the majority."

(FGDc-1) "Reading! Even university student knows how to read."

(FGDd-2) "Generally, it seems that teachers have stopped putting effort."

(FGDe-1) "Sometimes you have learned a lot and passed with good numbers, but you cannot teach well." It was also indicated that factual knowledge was discussed only, while the teachers need to emphasize concept understanding and its application.

To make teaching sessions more interesting, some students suggested having more interaction, incorporating videos and question-and-answer sessions, and inducing writing and drawing devices for multimedia that could be used to explain concepts.

(FGDa-2) "It is better to show the video lectures. I suggest that they have a writing device by which teachers write as they teach in the classroom."

Theme-2: Students' Motivation: Many participants agreed that there is a lack of motivation. Students do not feel motivated to attend lectures or participate in discussions. However, students did not precisely tie this theme to Biochemistry only but explained that it is present generally in our school.

(FGDa-1) "Biochemistry as a subject is a little dry and boring, and I feel like classes are even more boring. I don't feel like taking a class that is so boring."

(FGDd-2) "Lack of motivation is all around the campus."

(FGDb-2) "Taking lectures is like wasting time; do not feel satisfied after taking a class."

Theme-3: Clinical Irrelevance: Many participants agreed that they needed help understanding the clinical application of the topics taught in the early years of biochemistry. However, students from senior classes (3rd and 4th year) value the importance of biochemistry only after being exposed to clinical teaching.

(FGDe-2) "I've been listening since the first year. If you want to become a surgeon, keep anatomy strong. If you want to become a physician, choose physiology; I have never listened to biochemistry."

After further discussion, some of the suggestions were to familiarize students with the biochemistry course and its significance at the start of the module. In addition, demonstrating real patients or clinical scenarios during teaching sessions was also suggested to make biochemistry more clinically oriented.

(FGDe-2) "In the first biochemistry class, one thing to tell is the syllabus, and the second is the importance of biochemistry in MBBS and further in your field."

(FGDc-1) "We felt lagging (during the ward) that our basic sciences were not good, and we could not pick up things, so when is the future clinic? From the start, the clinic should be incorporated into basic sciences."

(FGDb-1) "During lectures, if we relate to real life, it will be easier for students to memorize topics."

Theme-4: Educational Needs:

This unified theme formed after a deep understanding of students' educational needs in this changing world. Students explicitly identified sub-themes like e-learning, the old teaching style, the need for more visually interesting content, on-demand teaching, and the desire to learn at their own pace. (FGDa-2) "yes! The teaching style is outdated."

(FGDd-1) "But now a generalized concept is established that we have enough sources on YouTube, gradually, gradually, school (on-campus) learning is fading, we come here to fun, we will learn when we get home."

It was noted that students are particularly inclined towards learning material available on online learning platforms. Students usually think that instead of consuming more time coming to the university and taking lectures, it's better to get information by watching online lectures and educational material available on the net.

(FGDa-1) "To be very honest, I would consider taking video lectures or YouTube lectures because they are far better than what we have been taught in lectures, and their teaching style is far better."

(FGDa-2) "I have not been here for about more than two hours. I can go home, play a video on 1. at speed and watch half an hour when the lecture is coisoverGDd-1) "Those (teachers) who only read slides, students are not listening because he is only reading slides, and later anyone will share pictures of slides, and later we can read from."

Theme-5: Difficulty in Transition: First-year medical students face challenges when they come to medical universities. Participant students described this theme as they experience a different educational environment at this campus compared to what they are used to in their high schools. Students mostly compared teaching methodology, the large number of students, time restriction, excess of content, and lack of interaction during teaching sessions.

(FGDa-1) "Yes, the transition is pretty hard for us to adjust."

(FGDa-2) "There was less number of students."

Theme-6: Students' Attitude: Few participants tried to analyze their behaviour after being probed during the discussion. They recognized that students do not attend class attentively and are equally responsible for not interacting and learning.

(FGDb-1) "There is a two way; students also have a role, and students do not try."

(FGDe-2) "This concept is fading from our minds that teachers means that there is no importance of teachers; we feel like this."

However, participants believed this lack of interest was solely due to poor classrooms and the inability to create curiosity among the students.

(FGDb-1) "No, the teacher's voice is audible, but in the back of the lecture hall, mostly the students sitting at the back don't want to study, just like us; when we don't want to study, we sit at the back."

(FGDe-1) "Sometimes, the teacher is teaching well, but we feel like the teacher is not teaching well because of noises and disturbances by other students."

Theme-7: Student Support: The lack of student counselling at the campus was a frequent concern for the participants. They feel solitary when they need advice for their academic problems or careers. Students also identified a communication gap between

their faculty teachers and students, for which they believe both are responsible on their part.

(FGDe-2) "Teachers have other roles as well, like spiritual guidance."

(FGDe-1) "And a little bit, to connect with the teacher, teacher other than studies, in (name of college) there is no career counselling, if we want to go abroad, do research, nothing."

Theme-8: Senior Peers: Junior students mostly look forward to guidance from their senior peers. Most of the participants explained the pessimistic guidance they received from seniors at the campus in their early days.

(FGDc-1) "Senior students tell them there is no need to study in detail; you can easily pass the exam by reading short books or MCQ's bank."

Teachers are judged by the reputations built by their senior peers. Students acknowledge that an educational environment exists in which senior students try to influence juniors and affect their opinions about teachers and assessment. Most of the time, junior students become overwhelmed by the suggestions they receive from their seniors.

(FGDe-2) "Junior students ask seniors so many things and make such opinions about teachers, as we say, so that belief has a strong role in treatment; once you have a belief that doctor's medicine will not work, it will never work."

Another growing trend was that senior students try to influence their juniors by showcasing their achievements and building their own followers. Participants from senior years suggested that college administration should play its role in making the educational environment more academically friendly.

(FGDe-1) "Seniors should be prepared before time, not to give, not allow to make any opinion, I mean students who have come, should experience and get exposure by themselves."

Theme-9: Curriculum Coherence: Many Students considered the curriculum not as good as it should be. Lack of coherence, missing topics, too many lectures, the need for more lab practicals, and introduction to multiple concepts in a single lecture were major problems highlighted by the students.

(FGDe-2) "In fact, I feel that There should be the same teacher who has taken the lecture. He has taken the lecture, all right. When students come to the tutorial, a discussion can be done. He knows what is

taught. The others completely do not know what is taught."

(FGDa-1) "There are many slides, 78, 80."

(FGDc-2) "Compared to the class, they give too much. Sometimes, teachers tell us, I know you are getting bored, and you cannot be taught further, but I have no other choice."

(FGDd-2) "Practicals should be increased when we come for practical; there was a practical experience, we get."

There was a general complaint that small group sessions like practicals and tutorials have also been conducted in the same fashion as lectures and need more interaction. A few of the participants highlighted that there is no introduction before each module that could have helped grasp the whole curriculum's holistic picture and suggested it be incorporated.

(FGDb-1) "Whenever there is a new module, we get it from seniors, the syllabus, but the teacher should give a full overview in the first class. For example, in the GIT module or particularly any module, we will learn this topic first, and it will end in this way."

Theme-10: Assessment: Many participants strongly criticized how the assessments were done and explained it as one reason students lose interest in studying biochemistry. This was a generalized experience that was also valid for other subjects. Some participants revealed that students practice surface approaches to pass the exams. In addition, it was also identified that some topics that needed to be added to the curriculum or taught were questioned in the examination.

(FGDe-1) "Things that were taught in exams, we feel that they have not been tested in exams, or if they are tested in a way that we were not taught in a class."

Few participants also recognized that assessments were only done at the end of the module and that no continuous assessments could help them prepare for their final exams.

(FGDc-1) "There are no frequent assessments."

(FGDe-2) "We had an internal evaluation. It came over us like that. Now we have to study anyway. We knew that we had to give a viva. We used to come prepared, and the output of all was good."

Students also recognized that there needs to be more communication between the examination and academic departments.

(FGDc-1)“Apparently, the Exam department was separate, and you guys sent MCQs, but MCQs were automatically selected; there were MCQs that were repeated, and even there were wrong MCQs.”

(FGDe-1)“Examination department is not in the hands of teachers, that is why there is a problem that things that have been taught are not asked, and those that have not been taught, completely not touched comes in the exam.”

Some participants from the 4th and final year also suggested having clinically oriented and case-based examinations in biochemistry so that they can apply their knowledge during clinical wards.

(FGDe-1)“At this level, we should get clinical case-oriented questions.”

Most participants also identified that the content of the final assessments has lost its uniqueness, and most of the MCQs are from previous years.

(FGDd-1)“Look! Students that have compiled past papers do MCQs from past papers just before one day, and they get passed, and those kids who learn the full module can get the same numbers because they were not fairly evaluated.”

(FGDe-2)“Past papers are given in exams directly, exact questions, and even wrong mcqs; in past papers, they come as they are.”

Some participants also suggested that the teacher who taught the topic should be responsible for creating the exam paper for the same topic.

(FGDb-2)“So, this happens that the Teacher who teaches the exam should be set by same. He knows what I have taught to students, so exams should be in the same way.”

To build a comprehensive understanding of the above-mentioned themes, the researcher confirmed the findings by analyzing the documents, curriculum, meeting minutes, and examination papers and observing the paper set at the same campus where this study was done. The researchers particularly observed that there was an integrated curriculum, but it has not been implemented in its true spirit because of its resource-intensive nature. Some identified reasons were lack of resources, motivation, skill set, and faculty and staff training.

DISCUSSION

This is a novel qualitative study exploring the students' perceptions and felt needs to understand the

learning gaps in current teaching and learning practices in Medical Biochemistry. As a result, ten major themes were generated from FGDs. These themes will help to explain the causes of the learning gaps and their suggestions.

The teachers' lack of appropriate teaching strategies was a generalized complaint among participants. The learning environment created by teachers majorly affects students' motivation and attitude.¹⁵ According to studies, students perceive good teachers by their attributes like purposeful, task-oriented, warm, supportive, enthusiastic, and extrovert. However, subject knowledge, pedagogy, and professionalism are necessary but do not discriminate good from bad teachers.^{16,17}

The abundance of traditional didactic lectures, cognitive overload, absence of concept understanding, and its application were some of the few concerns that the participants highlighted. Cognitive psychology suggests that concepts are easier to remember when discussed with students by elaborating, questioning and relating to examples.¹⁸

During pre-clinical years, students too often perceive biomedical sciences as irrelevant to clinical practice.^{19,20} This partly reflects the pitfalls in the curricula, which need to offer adequate time and effort for a true understanding of science and link it to a sophisticated approach to thinking in the clinical setting.⁷ Difficulty in recall and lack of clinical relevance are some of the usual feedbacks received by teachers from most medical students, which are well established by previously published study 11 and in accordance with the findings of this study.

As perceived by the participants in this study, lack of motivation among students, incoherent curriculum, and the subject's clinical irrelevance are interconnected phenomena. The purpose of higher education should only be deep learning instead of surface approaches frequently used by the students.²¹ A study found that lack of clinical application and rote memorization are the major causes of apathy towards Biochemistry. ³ Heflin *et al.* correctly said, 'All sorts of ideas, if left to themselves, are gradually forgotten', emphasizing the need for effective instructional strategies in curricula to improve long-term retention of the subject.²²

This drawback could be addressed by incorporating learning outcomes that start deep learning and integrated problem-based teaching strategy that will equip students with the lifelong

knowledge required for a medical professional.²³ Various other studies have also suggested replacing traditional lectures with modern student-centred teaching strategies like case-based and problem-based learning, Peer-assisted learning, e-learning, and flipped classroom.^{24,25} This will improve students' clinical reasoning skills, critical thinking, and other competencies.

Due to social media platforms and easy access to the internet and technology, traditionally practised teaching methods are no longer pertinent among students. Our study identified this phenomenon as the "educational need" for a changing world. Studies showed that students' attention span declines sharply between ten to fifteen minutes during a lecture, while the average time spent on a web page is only eight seconds.²⁶ This suggests that as a teacher, you must grab students' attention in less than eight seconds and transfer the most important information in less than fifteen minutes. In this era of technology, it is even more difficult to engage students. Students' limited attention resources are now easily consumed by the burst of information in our ecosystem. To overcome these barriers, teachers must use technology-enhanced learning via online learning platforms, video lectures, e-modules, and social media to engage students.^{27,28}

Positive peer-assisted learning, faculty interaction, mentoring, and student support should address these phenomena, such as inappropriate student attitudes, poor guidance by senior peers, and stress caused by transition.

Inappropriate assessment was one of the loudest themes in the FGDs. Senior participants from the fourth and fifth years were not satisfied with how they were assessed. They believed it was a barrier to achieving the competencies required during clinical rotations. Some frequent complaints are a lack of continuous assessment, not being aligned with the topics being taught, not being clinically oriented, and mostly repeating past papers.

This study will serve as the basis for bridging the gap between teaching and learning biochemistry in undergraduate medical programs. New pedagogical strategies and the needs of the students should be incorporated to achieve the ultimate goal of improved patient care.

RECOMMENDATIONS

This study provides insights and suggestions to bridge the existing gap in teaching and learning in

Biochemistry. Because of our findings and the latest research articles, we propose the following measures to achieve the intended learning outcomes of the biochemistry curriculum. Teachers' training programs should be mandatory and encouraged to support students passionately. An integrated curriculum is resource-intensive, so it should be paired with its needs, such as learning resources and persons with the required skill set. The researcher also believes that identifying biochemistry competencies required for medical graduates is becoming increasingly important and should be explicitly stated in the curriculum.

Students' negative attitudes towards learning must be challenged to prevent apathy and disengagement among students. Steps like a student mentoring program and timely feedback on their progress provided by the teachers should be incorporated. Similarly, assessment quality should be enhanced to motivate students to utilize deep and strategic learning approaches. These measures include exam blueprinting, choosing suitable assessment formats, including all cognitive, psychomotor, and affective domains of learning, clinically oriented format, and faculty involvement in making assessment material.

To be more purposeful and task-oriented, modern instructional methods like flipped classrooms and problem-based learning should replace many traditional lectures. In addition, Technology-enhanced learning should be encouraged to enhance students' academic satisfaction, engagement, and achievement. Some transformative measures that could be used are designing e-modules for a few learning blocks in the curricula, using departmental e-logs for continuous assessment and making student learning communities on social media.

LIMITATIONS OF STUDY

This study was confined to a uni-centric setting. The site was purposefully selected because of the nature of its identified research problem and its relationship with the college's learning environment. However, this decreases the external validity, and the findings may be generalized with caution to another setting or population.

ACKNOWLEDGEMENT

We want to acknowledge all students and faculty involved in this study.

CONCLUSION

This study concludes that teaching, students' motivation, clinical irrelevance, educational needs, difficulty

in transition, student attitude, student support, senior peers, curriculum coherence, and assessment are potential sources of learning gaps to achieve intended learning outcomes of biochemistry for medical students. This study also explored new teaching and learning strategies, considering students' perceptions and felt needs.

Conflict of Interest: None.

Authors Contribution

Following authors have made substantial contributions to the manuscript as under:

SDHA: Data acquisition, data analysis, critical review, approval of the final version to be published.

AU: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

1. Malau-Aduli BS, Alele FO, Heggarty P, Teague PA, Sen Gupta T, Hays R, et al. Perceived clinical relevance and retention of basic sciences across the medical education continuum. *Adv Physiol Educ* 2019; 43(3): 293-299. <http://doi.org/10.1152/advan.00012.2019>
2. Mbiydzanyuy NE, Chisompola NK. Basic Medical Sciences in Medical Education: A Thought for African Medical Schools. *Med Sci Educ* 2020; 31(1): 253-256. <http://doi.org/10.1007/s40670-020-01145-2>
3. Afshar M, Han Z. Teaching and Learning Medical Biochemistry: Perspectives from a Student and an Educator. *Med Sci Educ* 2014; 24(3): 339-341. <http://doi.org/10.1007/s40670-014-0004-7>
4. Pienta NJ. The Role of Chemistry Education for Medical Preprofessionals. *J Chem Educ* 2017; 94(8): 981-982. <http://doi.org/10.1021/acs.jchemed.7b00527>
5. Thomas PA, Kern DE, Hughes MT, Tackett SA, Chen BY. Curriculum development for medical education: A six-step approach. Johns Hopkins University Press; 2015.
6. Finnerty EP, Chauvin S, Bonaminio G, Andrews M, Carroll RG, Pangaro LN, et al. Flexner revisited: the role and value of the basic sciences in medical education. *Acad Med* 2010; 85(2): 349-55. <http://doi.org/10.1097/ACM.0b013e3181c88b09>
7. Woods NN. Science is fundamental: the role of biomedical knowledge in clinical reasoning. *Med Educ* 2007; 41(12): 1173-1177. <http://doi.org/10.1111/j.1365-2923.2007.02911.x>
8. Sockalingam S, Hawa R, Al-Batran M, Abbey SE, Zaretsky A. Preparing international medical graduates for psychiatry residency: a multi-site needs assessment. *Acad Psychiatry* 2012; 36(4): 277-281. <http://doi.org/10.1176/appi.ap.09110219>
9. Oskvarek J, Braunstein S, Farnan J, Ferguson MK, Hahn O, Henderson T, et al. Medical Student Knowledge of Oncology and Related Disciplines: a Targeted Needs Assessment. *J Cancer Educ* 2016; 31(3): 529-532. <http://doi.org/10.1007/s13187-015-0876-2>
10. Dandekar SP, Maksane SN, Mckinley DW. Design of Medical Biochemistry Undergraduate Laboratory Based Curriculum to Address Unmet Needs. *South-East Asian J Med Educ* 2017;11(1). 43-53. <http://doi.org/10.4038/seajme.v11i1.8>
11. D'Souza JM, Raghavendra U, D'Souza DH, D'Souza ND. Teaching learning of biochemistry in undergraduate medical curriculum: Perceptions and opinions of medical students. *Educ Med J* 2013; 5(2): e45-53. <http://doi.org/10.5959/eimj.v5i2.109>
12. Creswell JW, Poth CN. Qualitative inquiry and research design: Choosing among five approaches. Sage Publications; 2016.
13. Krueger RA. Focus groups: A practical guide for applied research. Sage Publications; 2014.
14. Byrne D. A worked example of Braun and Clarke's approach to reflexive thematic analysis. *Qual Quant* 2022; 56(3): 1391-1412. <http://doi.org/10.1007/s11135-021-01182-y>
15. Hafeez A, Jamil B, Khan AF. Roadblocks to Integration; Faculty's perspective on transition from Traditional to Integrated Medical Curriculum. *Pak J Med Sci* 2021; 37(3): 788-793. <http://doi.org/10.12669/pjms.37.3.3217>
16. Dahdal S. Using the WhatsApp social media application for active learning. *J Educ Technol Sys* 2020; 49(2): 239-249. <https://doi.org/10.1177/0047239520928307>
17. Radmacher SA, Martin DJ. Identifying significant predictors of student evaluations of faculty through hierarchical regression analysis. *J Psychol* 2001; 135(3): 259-268. <http://doi.org/10.1080/00223980109603696>
18. Krueger PM, Neutens J, Bienstock J, Cox S, Erickson S, Goepfert A, et al. To the point: reviews in medical education teaching techniques. *Am J Obstet Gynecol* 2004; 191(2): 408-411. <http://doi.org/10.1016/j.ajog.2004.02.003>
19. Custers EJ, Ten Cate OT. Medical clerks' attitudes towards the basic sciences: a longitudinal and a cross-sectional comparison between students in a conventional and an innovative curriculum. *Med Teach* 2007; 29(8): 772-777. <http://doi.org/10.1080/01421590701509696>
20. West M, Mennin SP, Kaufman A, Galey W. Medical students' attitudes toward basic sciences: influence of a primary care curriculum. *Med Educ* 1982; 16(4): 188-191. <http://doi.org/10.1111/j.1365-2923.1982.tb01246.x>
21. McPhail G. The search for deep learning: A curriculum coherence model. *J Curr Stud* 2020; 53(4):420-434. <http://doi.org/10.1080/00220272.2020.1748231>
22. Heflin H, Shewmaker J, Nguyen J. Impact of mobile technology on student attitudes, engagement, and learning. *Comput Educ* 2017; 107: 91-99. <https://doi.org/10.1016/j.compedu.2017.01.006>
23. Yan Q, Ma L, Zhu L, Zhang W. Learning effectiveness and satisfaction of international medical students: Introducing a Hybrid-PBL curriculum in biochemistry. *Biochem Mol Biol Educ* 2017; 45(4): 336-342. <http://doi.org/10.1002/bmb.21046>
24. Challa KT, Sayed A, Acharya Y. Modern techniques of teaching and learning in medical education: a descriptive literature review. *Med Educ Pub* 2021;10:18. <http://doi.org/10.15694/mep.2021.000018.1>
25. Thai NT, De Wever B, Valcke M. The impact of a flipped classroom design on learning performance in higher education: Looking for the best "blend" of lectures and guiding questions with feedback. *Comput Educ* 2017; 107: 113-126. <http://doi.org/10.1016/j.compedu.2017.01.003>
26. Bradbury NA. Attention span during lectures: 8 seconds, 10 minutes, or more? *Adv Physiol Educ* 2016;40(4):509-513. <http://doi.org/10.1152/advan.00109.2016>
27. Rajabalee YB, Santally MI. Learner satisfaction, engagement and performances in an online module: Implications for institutional e-learning policy. *Educ Inf Technol* 2021; 26(3): 2623-2656. <http://doi.org/10.1007/s10639-020-10375-1>
28. Logan RM, Johnson CE. Development of an e-learning module to facilitate student learning and outcomes. *Teach Learn Nurs* 2021; 16(2): 139-142. <https://doi.org/10.1016/j.teln.2020.10.00>