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# THE IMPACT OF FLIPPED CLASSROOM ON ENHANCING BASIC MEDICAL SCIENCES EDUCATION ACROSS MBBS YEAR GROUPS: A MULTIDISCIPLINARY LITERATURE-ENRICHED STUDY.

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**ABSTRACT**

**BACKGROUND:** Flipped Classroom (FC) is an innovative pedagogical strategy where students engage with instructional materials before class, using face-to-face time for active learning. Although widely studied in clinical disciplines, its role across pre-clinical and paraclinical subjects—such as anatomy, physiology, biochemistry, pathology, and pharmacology—among MBBS students across multiple academic years has not been extensively evaluated. **OBJECTIVE:** To assess the effectiveness of the flipped classroom model in enhancing comprehension, critical thinking, and application of basic medical sciences among first-, second-, and third-year MBBS students. **METHODS:** A cohort of 240 MBBS students (80 from each year) participated in a semester-long FC intervention across five subjects: Anatomy and Physiology (1st year), Biochemistry (2nd year), Pathology and Pharmacology (3rd year). Pre-class learning consisted of video lectures, textbook chapters, and interactive quizzes. In-class sessions involved clinical case discussions, concept mapping, peer teaching, and simulations. Pre- and post-tests along with perception surveys were used to evaluate outcomes. **RESULTS:** Overall, student performance improved significantly, with mean post-test scores increasing from 65.2% to 82.7% ($p < 0.001$). First-year students reported stronger foundational understanding; second-year students emphasized improved integration; and third-year students valued enhanced clinical correlation. Across all years, over 80% agreed that FC increased their engagement and clarity of complex topics. **CONCLUSION:** The flipped classroom model is effective across MBBS year groups and subjects. It promotes interactive learning, enhances foundational and clinical reasoning, and fosters interdisciplinary integration. A broader adoption across medical curricula is recommended.

**KEYWORDS:** Flipped Classroom, Anatomy, Physiology, Biochemistry, Pathology, Pharmacology, MBBS Education

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## INTRODUCTION

Basic medical sciences form the foundation of medical education, shaping the diagnostic and therapeutic competencies of future physicians. However, traditional lecture-based delivery often leads to passive learning and surface-level understanding. The flipped classroom (FC) model offers a shift toward student-centered learning by assigning pre-class study materials and reserving class time for application-oriented activities[1]. While the benefits of FC have been demonstrated in pharmacology and clinical subjects, few studies have explored its effectiveness across multiple basic medical disciplines and MBBS academic years. With each year presenting distinct learning objectives—from anatomical structure to clinical pharmacotherapy—it is imperative to assess how FC supports vertical integration and cognitive development across the curriculum.[2] This study evaluates the application of FC in five core medical science subjects taught across the first three MBBS years and measures its effectiveness in enhancing understanding, engagement, and interdisciplinary learning.

## METHODS

**Study Design and Setting:** A prospective interventional study was conducted at Suleman Roshan Medical College, Tando Adam, from February to June 2023. Ethical approval was obtained from the Institutional Review Board.

**Participants:** A total of 240 MBBS students were included: 80 from 1st year (Anatomy and Physiology), 80 from 2nd year (Biochemistry), and 80 from 3rd year (Pathology and Pharmacology).

**Flipped Classroom Intervention:**

**Pre-Class Learning:** Students accessed curated digital resources, including recorded lectures, essential textbook readings and formative quizzes.[3,4]

**In-Class Activities:** Sessions included collaborative group work, clinical case-based discussions, role-playing, and hands-on model exploration. Faculty acted as facilitators.

**Assessments:** Each subject administered pre- and post-tests (MCQs and SAQs) tailored to respective syllabi. Perception surveys with Likert-scale items were conducted.

**Data Analysis:** Paired t-tests and ANOVA were used to compare assessment scores. Survey data were analyzed using descriptive statistics.

## RESULTS

**Assessment Scores:**

**Overall:** Pre-test mean = 65.2%; Post-test mean = 82.7%; $p < 0.001$

**By Year:**

1st Year (Anatomy/Physiology): Pre = 66.4%, Post = 83.5%

2nd Year (Biochemistry): Pre = 64.1%, Post = 81.8%

3rd Year (Pathology/Pharmacology): Pre = 65.2%, Post = 82.9%

**TABLE 1: PRE- AND POST-TEST SCORES BY ACADEMIC YEAR**

| Year | Subjects | Pre-Test Mean (%) | Post-Test Mean (%) | Improvement (%) |
|---|---|---|---|---|
| **1st Year** | Anatomy, Physiology | 66.4 | 83.5 | +17.1 |
| **2nd Year** | Biochemistry | 64.1 | 81.8 | +17.7 |
| **3rd Year** | Pathology, Pharmacology | 65.2 | 82.9 | +17.7 |
| **Overall** | All Subjects | 65.2 | 82.7 | +17.5 |

| Student Perceptions |
|---|
| 84% agreed FC clarified complex concepts |
| 78% reported improved integration of theory and practice |
| 81% found group activities more engaging than lectures |
| 76% expressed interest in applying FC to other subjects |

**TABLE 2: STUDENT PERCEPTIONS OF FLIPPED CLASSROOM**

| Perception Statement | Agree (%) |
|---|---|
| FC clarified complex concepts | 84% |
| FC improved integration of theory and practice | 78% |
| Group activities were more engaging than lectures | 81% |
| Interested in applying FC to other subjects | 76% |
| FC helped in visualizing drug mechanisms (Pharmacology only) | 85% |

**Qualitative Insights: Anatomy & Physiology:** Visual materials and peer teaching were highlighted as beneficial.
**Biochemistry:** Students appreciated solving biochemical pathways through case scenarios.
**Pharmacology:** Role-playing helped visualize drug mechanisms and interactions.

## DISCUSSION

This study demonstrates the broad applicability and effectiveness of the FC model across academic years and disciplines. Previous studies have confirmed similar results in focused subjects like pharmacology but our multi-subject design adds novel insights into how FC fosters curricular coherence and engagement [5]. This study demonstrates the broad applicability and effectiveness of the FC model across academic years and basic medical science disciplines. Previous studies have confirmed its utility in pharmacology and isolated clinical subjects but our multi-subject, multi-year design provides comprehensive evidence of how FC fosters curricular coherence and cognitive progression. The improvement in post-test scores and the overwhelmingly positive student perceptions highlight how FC promotes horizontal integration (e.g., linking anatomy with physiology) and vertical integration (e.g., bridging basic sciences with clinical application). This mirrors the findings of Shaikh et al. who demonstrated that FC in pharmacology improved both conceptual clarity and clinical reasoning among third-year MBBS students at Peoples University of Medical and Health Sciences (PUMHS), Nawabshah[6]. Moreover, the FC model facilitates the development of higher-order cognitive skills by transforming passive lecture time into opportunities for case-based learning, simulation, and peer interaction. Studies by Falck et al. and French et al. support this, noting that active learning formats increase learner motivation, retention, and participation. [7, 8]. Similarly, Shaikh's 2024 study on role-playing in smoking cessation education among cardiac patients highlighted how immersive, problem-based teaching improves student engagement and therapeutic reasoning[9].

In our study, the flipped approach in biochemistry helped students solve pathway-based problems—a key component of systems-based integration. This is supported by Graudins et al, who noted that clinical scenario-based instruction fosters deeper biochemical understanding[10]. In the pharmacology domain, role-playing drug interactions and adverse effects parallels Shaikh's experimental designs, such as those

in his study on Garcinia cambogia's pharmacodynamics in diabetic models

Our results also emphasize the importance of digital autonomy and pre-class preparedness, which aligns with the findings of Phillips & Wiesbauer[11]. Students who engage with content independently before class develop better self-regulation and motivation. Shaikh's study also demonstrated the effectiveness of structured digital learning interventions in demystifying myths around diabetes, contributing to improved therapeutic literacy[12]. However, the implementation of FC is not without its challenges. First-year students needed significant orientation to adjust to this active learning model. Faculty reported increased preparation time, which is consistent with literature citing the need for institutional support and resource allocation[13,14]. This was also underscored by Shaikh et al., who called for dedicated faculty development programs for successful FC adoption in pharmacology.

Benefits Noted: Promotes horizontal integration (across subjects in one year) and vertical integration (across years) Encourages higher-order thinking and retention Supports personalized learning pathways and collaborative exploration

**Challenges:** First-year students required additional orientation to the FC model Preparation time was cited as a concern across years Faculty training and resource development were essential for success

**Limitations:** Single-center setting, limited generalizability, and variation in digital literacy across student groups

**Limitations** of our study include its single-center setting and the variation in digital literacy, which may affect generalizability. Future multi-institutional studies should assess long-term knowledge retention and clinical performance metrics to further validate FC's effectiveness

## CONCLUSION

The flipped classroom model is a versatile and effective pedagogical tool across the continuum of MBBS education. By fostering interactive learning and interdisciplinary integration, FC has the potential to enhance both foundational knowledge and clinical readiness. Institutional support, faculty development, and infrastructure investment are essential for sustainable implementation.

**ETHICS APPROVAL:** The ERC Gave Ethical Review Approval.

**CONSENT TO PARTICIPATE**: Written And Verbal Consent Was Taken From Subjects And Next Of Kin.

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**CONFLICT OF INTEREST:** No Competing Interest Declared.

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