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Original Article

Physiology Section

# Role of Blended Learning in Imparting Early Clinical Exposure in Physiology for First-year Medical Students: An Educational Interventional Study

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## ABSTRACT

**Introduction:** Blended learning is a combination of online and face-to-face learning. With the introduction of a competency-based curriculum in India and Early Clinical Exposure (ECE) as a part of it, there is a need for innovative learning methods like the Blended Learning Method (BLM).

**Aim:** To analyse the effectiveness of BLM in implementing ECE compared to the Non BLM or traditional method.

**Materials and Methods:** This educational interventional study was conducted at the National Institute of Medical Sciences and Research, NIMS University, Jaipur, Rajasthan, India from April 2022 to October 2022. The sample population included Phase 1 MBBS students (n=110). Students were randomly assigned to two groups: the BLM group and the Non BLM group, each consisting of 55 students. The BLM group received ECE through a combination of digital and face-to-face methods, while the Non BLM group received traditional face-to-face ECE. Students' performance was evaluated through standardised assessments. Students' and faculty perceptions of the BLM method were assessed using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

**Results:** The comparison of pretest scores between both groups was statistically not significant. However, the post-test score comparison was statistically significant (p-value <0.05) for a few ECE sessions (sessions 1 and 3), with better performance observed in the BLM group. The paired t-test between pre and post-test scores was highly significant in both the BLM and Non BLM groups (p-value <0.0001). The student perception of the use of BLM was positive, while faculty perception indicated that they had difficulty using the BLM method to implement ECE.

**Conclusion:** BLM can be an effective tool in the implementation of ECE sessions in physiology. It can enhance the self-directed learning ability of students.


**Keywords:** Active learning, Clinical integration, e-learning

## INTRODUCTION

Blended learning is a combination of online and face-to-face learning [1]. This approach is essential for substantiating students' understanding. There are many ways in which blended learning can be implemented. One such method involves individuals learning from online modules independently and then coming together for dynamic interaction in group sessions [2]. According to Whitelock D and Jelfs A, blended learning is the combination of tools embedded within an e-learning environment or the integration of several pedagogical approaches, irrespective of the technology used [3]. According to Chodorow S, e-learning approaches are associated with increased learner satisfaction, although some studies indicate that e-learning may lead to less social interaction among students [4]. Research conducted by Ruiz JG et al., demonstrated that BLM are as effective as traditional didactic approaches and can promote self-directed learning [5]. According to Ellaway R and Masters K, BLM provides learners with greater control over their learning and helps teachers evaluate competencies through online assessments, enabling learners to receive feedback for self-improvement [6]. It is well documented in the literature that the use of e-learning resources can supplement medical education, as these resources are easily accessible and facilitate flexible, on-demand training [7].

ECE is a teaching and learning methodology that introduces medical students to patient interactions as early as their first year of medical school. Today, ECE programs are a fundamental aspect of medical education in many countries worldwide [8-14]. ECE integrates clinically relevant material and patient interactions from the first year, enhancing the cognitive, psychomotor, and affective learning domains crucial for future physicians. Research indicates that ECE effectively complements traditional theoretical teaching and enhances the performance of new medical students in basic sciences [15]. Additionally, it aids in the development of clinical reasoning [8,16,17].

In a study by Tayade MC et al., and Wenrich MD, it was concluded that ECE significantly impacted all three learning domains (knowledge, skills, and attitudes) in students, who also found it useful and interesting [8-10]. ECE helps students develop empathy and adopt a patient-centered approach [18]. Students reported high satisfaction with the ECE protocol, noting that it enhanced their knowledge and helped them understand the relevance of preclinical subjects in a clinical context, as indicated by a study conducted by Gupta K et al., [19].

With the introduction of a competency-based curriculum in India and the inclusion of Early Childhood Education (ECE) as a part of it, there is a need for innovative learning methods such as BLM. Therefore, this study is important to analyse the implementation of ECE through BLM and to compare it with the implementation of ECE through non blended, traditional methods.

The aim of the study was to assess the performance of students in both groups, namely the BLM and Non BLM groups, and to compare the performance of students in these two groups and also to analyse the perceptions of students and faculty regarding the implementation of ECE in physiology through blended learning.

### Research Hypothesis

**Null hypothesis ($H_0$):** There is no significant difference in student performance and engagement in ECE sessions in physiology between the BLM and Non BLM groups.

**Alternate hypothesis ($H_1$):** The BLM is significantly more effective in enhancing student performance and engagement in ECE sessions in physiology compared to the Non BLM.

## MATERIALS AND METHODS

An educational interventional study was conducted at the National Institute of Medical Sciences and Research (NIMS University) in Jaipur, Rajasthan, India from April 2022 to October 2022. The sample population included Phase 1 MBBS students. The study was conducted after obtaining approval from the Institutional Ethics Committee (IEC), with the IEC letter number NIMSUR/IEC/2022/227. Written informed consent was obtained from all participants in the study.

**Inclusion criteria:** Students who were willing to provide informed written consent were included in the study.

**Exclusion criteria:** Students who were unwilling to give informed written consent were excluded from the study.

**Sample size:** Using the Input Parameters:

Standardised Effect Size (Cohen's d)=0.5

Significance Level (α)=0.05

Power (1-β)=0.8

Population Size (N): 150

Initial sample size was calculated using a two-tailed test for a comparison of means between two independent groups, the formula is:

1. n=(dZα/2+Zβ)2×2

   Where,

   - Zα/2=1.96 for a 0.05 significance level

     Zβ=0.84 for 80% power

     n=62.72 or 63

2. Adjusting for finite population i.e., 150

   N, adjusted=n/1+n−1/N

   N, adjusted=45.

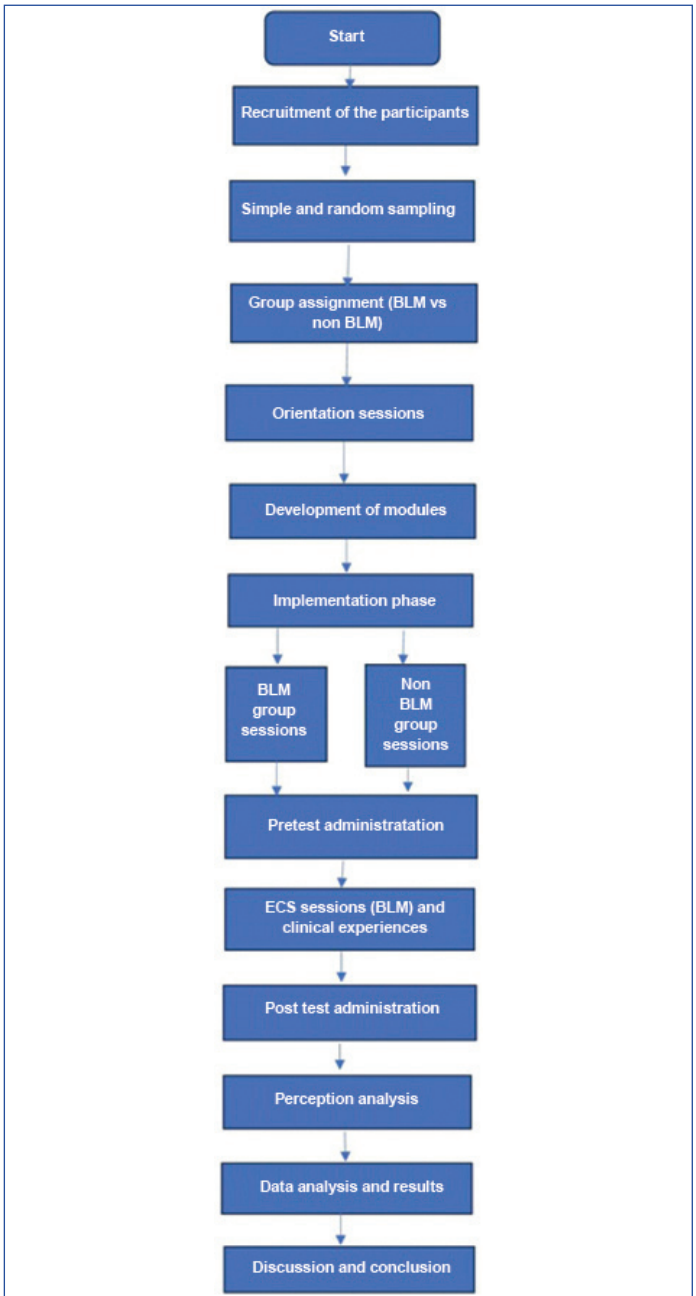
Therefore for two groups, the total sample size would be 45×2=90

In this study, a total sample size of 110 was taken. Among the 110 students, 67 were girls and 43 were boys.

### Study Procedure

The method of allocation employed was a lottery method. Initially, a comprehensive list of all 110 Phase 1 MBBS students eligible for the study was compiled using their class roll numbers. Subsequently, lottery slips were created, with each slip bearing the roll number of an individual student. To prevent bias, all slips were uniform in size and shape. Next, all slips were placed into a large, opaque container and thoroughly mixed to ensure randomisation. Slips were then drawn one by one from the container without viewing them. The first 55 slips drawn were designated for the BLM group, while the subsequent 55 slips were assigned to the Non Blended Learning (Non BLM) group. This method ensured that both groups were selected randomly and impartially from the pool of eligible participants.

Both faculty and students were sensitised about the Blended Learning Environment (BLE) through orientation sessions, workshops, and demonstrations that highlighted the integration of digital tools with traditional teaching methods. The physiology faculty underwent comprehensive training to develop modules on five ECE topics. These modules incorporated both digital and traditional components and were specifically customised for blended learning in the BLM group and traditional non blended learning in the Non BLM group [Table/Fig-1].




**[Table/Fig-1]:** Flow chart describing the steps followed in methodology.

Blended Learning Methodology (BLM) Customisations:

- Digital Tools Integration:
- Interactive videos: Short, interactive video lectures on key physiology concepts related to ECE topics.
- Online quizzes: Regular online quizzes to assess understanding and provide instant feedback.
- Web-based case study resources.

Non Blended Learning Methodology (Non BLM) Customisations:

- Traditional Teaching Methods:
- Lectures: In-person lectures as the primary mode of instruction without supplementary digital content.
- Non Digital Resources:
- Printed materials: Handouts, worksheets, and printed case studies for use in class.
- Chalk-and-Talk: Traditional blackboard teaching methods without the use of multimedia tools.

These customisations ensure that the BLM integrates digital tools with traditional methods to create a comprehensive learning

environment, while the Non BLM relies solely on traditional, non digital teaching methods.

For both groups, a series of ECE sessions focused on key physiology topics were conducted:

1. Myocardial Infarction:
    - Pathophysiology of atherosclerosis and coronary artery disease.
    - Details on ST segment elevated myocardial infarction and non-ST segment elevation myocardial infarction using ECG findings and clinical symptoms.
    - Management strategies for both types of myocardial infarction.
2. Renal Diseases and Principles of Dialysis:
- Pathophysiology of acute and chronic renal failure (ARF and CRF).
- Clinical differentiation between ARF and CRF using symptoms and renal function tests.
- Management and treatment of renal failure, with a focus on dialysis.
3. Diabetes Mellitus:
    - Pathophysiology of diabetes mellitus.
    - Types of diabetes mellitus and diagnostic tests.
    - Management approaches for diabetes mellitus.
4. Basal Ganglia and its Disorders:
    - Pathophysiology of the basal ganglia.
    - Symptoms, diagnosis, and management of Parkinson's disease.
    - Details on hyperkinetic disorders related to the basal ganglia, such as Huntington's chorea, athetosis, ballismus, and hemiballismus.
5. Thyroid Disorders:
    - Pathophysiology of the thyroid gland, including thyroid hormones, synthesis, and functions.
    - Causes, pathology, diagnosis, and management of hyperthyroidism and hypothyroidism.

These sessions were structured to provide a comprehensive understanding and practical exposure to physiological conditions, ensuring both groups received targeted education through their respective learning methodologies. Each session included a detailed explanation of physiological principles, interactive discussions, and case-based learning activities.

To eliminate bias, the content of the sessions was meticulously planned and standardised across both groups. Detailed lesson plans were created and followed for each topic to ensure that the same information, activities, and teaching materials were used. Instructors were trained to deliver the sessions uniformly, adhering strictly to the prepared lesson plans. Periodic checks and observations were conducted to ensure consistency in teaching methods and content delivery across both groups.

The BLM group received a combination of traditional face-to-face instruction and digital learning components. The digital components included video lectures, interactive modules, and online quizzes. The face-to-face sessions were designed to complement the online materials, with a focus on discussion and problem-solving exercises.

The Non BLM group received traditional face-to-face instruction only. The content covered in these sessions was identical to the content provided in the BLM group's face-to-face sessions.

### Implementation in the BLM Group

The ECE began with an introductory face-to-face lecture covering the learning objectives, which were built around a clinical scenario (30 minutes). Following this introductory session, multiple short lecture video segments featuring clinical cases and related basic science topics, along with built-in quizzes, were released online. This content totaled 45 minutes, after which students were given additional time to understand, assimilate, and conceptualise the material (45 minutes). In total, this segment lasted 90 minutes. The summary and conclusion were delivered in a face-to-face or offline format, highlighting key learning points (30 minutes). Finally, reflection on what was learned, with guidance and monitoring, also took place face-to-face (30 minutes).

### Implementation in non BLM Group

The ECE started with an introductory lecture covering the learning objectives built around a clinical scenario (30 minutes). This was followed by a classroom clinical experience, which included a case study and related clinical material, lasting one hour and 30 minutes. A summary and conclusion, highlighting key learning points, took place for 30 minutes. Finally, there was a 30-minute reflection session, where participants received guidance and monitoring on what they had learned.

Pretest and post-test questionnaires were prepared and validated by six subject experts. The tests were conducted using Google Forms, with 10 multiple-choice questions administered. Participants were given 10 minutes to complete the test. The pretest was conducted for both groups to assess and compare their baseline knowledge before providing overview documents for each ECE session. Overview documents containing the learning objectives of the ECE were distributed to both groups four days prior to the commencement of the ECE session. The post-test was conducted immediately after the session for both groups, using the same questions for both the pretest and post-test.

Two different survey questionnaires were developed to analyse the perceptions of students and faculty regarding the implementation of ECE using the BLM method. These questionnaires were validated by six experts, and a short pilot study was conducted. The internal consistency and reliability of the items were assessed and validated by calculating Cronbach's Alpha, which was found to be 0.931889. The questionnaires were created using Google Forms and distributed through the WhatsApp groups of teachers and students, with responses collected via email.

The ECE was implemented using the BLM method for the BLM group and the face-to-face method for the non BLM group on the same day in two lecture galleries. Two different faculty members, who had been trained on how to conduct the ECE session using both the BLM and non BLM methods, facilitated the sessions.

## STATISTICAL ANALYSIS

The statistical significance of the means of pretest and post-test scores for group A and group B was assessed using the Student's t-test. An Independent samples t-test was used for comparisons between groups A and B, while a paired t-test was used for within-group comparisons. Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS) version 20.0. A p-value of $<0.005$ was considered statistically significant. The perceptions of students and faculty were assessed using a 5-point Likert scale, which was expressed as follows: strongly disagree (1), disagree (2), neither agree nor disagree (3), agree (4), and strongly agree (5).

## RESULTS

The mean age of the students was 19.12±1.02 years. All 110 students participated in the study and attended all five sessions. There were no dropouts, as the sessions were conducted on days when all 110 students were present. Additionally, they were given prior information to attend the sessions.

An independent sample t-test was conducted to compare the pretest scores of the two groups, which showed no statistical significance. However, there was a statistically significant difference in the post-test scores of the two groups for several ECE sessions (sessions 1 and 3), with better performance from the BLM group [Table/Fig-2].

The paired t-test comparing pretest and post-test scores for both groups demonstrated high statistical significance, with the means of the post-test scores being higher [Table/Fig-3,4].

| Pre/post-test | Mean±SD | | p-value <0.05 | Effect size |
|---|---|---|---|---|
| | BLM | Non BLM | | |
| Pretest of session 1 | 6.52±1.22 | 6.45±1.08 | 0.7506 | 0.061 |
| Post-test of session 1 | 11.58±1.56 | 10.90±1.69 | 0.0305 | 0.417 (s) |
| Pretest of session 2 | 9.14±3.10 | 9.61±3.24 | 0.5039 | -0.148 |
| Post-test of session 2 | 11.78±2.56 | 11.22±1.877 | 0.1930 | 0.25 |
| Pretest of session 3 | 6.98±1.43 | 7.09±1.68 | 0.7123 | -0.071 |
| Post-test of session 3 | 10.66±1.23 | 9.79±1.56 | 0.0015 | 0.62 (m) |
| Pretest of session 4 | 8.56±1.66 | 8.24±1.78 | 0.3317 | 0.186 |
| Post-test of session 4 | 12.46±1.67 | 12.84±1.96 | 0.2762 | 0.209 |
| Pretest of session 5 | 7.89±1.56 | 7.45±1.78 | 0.1708 | 0.264 |
| Post-test of session 5 | 10.66±1.45 | 10.08±1.62 | 0.0504 | 0.378 (s) |

**[Table/Fig-2]:** Comparison of mean and SD between BLM and Non BLM groups Independent sample t-test was used. Effect size d=0.3 to 0.5 is small (s) 0.5 to 0.8 is medium (m) >0.8 is large (l).

| ECE session | Mean±SD | | Effect size | p-value |
|---|---|---|---|---|
| | Pretest | Post-test | | |
| 1st session | 6.52±1.22 | 11.58±1.56 | -3.614 (l) | <0.0001 |
| 2nd session | 9.14±3.10 | 11.78±2.56 | -0.929 (l) | <0.0001 |
| 3rd session | 6.98±1.43 | 10.66±1.23 | -2.77 (l) | <0.0001 |
| 4th session | 8.56±1.66 | 12.46±1.67 | -2.34 (l) | <0.0001 |
| 5th session | 7.89±1.56 | 10.66±1.45 | -1.84 (l) | <0.0001 |

**[Table/Fig-3]:** Comparison of pre and post-test scores of BLM group.
Effect size d=0.3 to 0.5 is small (s) 0.5 to 0.8 is medium (m) >0.8 is large (l). Paired t-test was used

| ECE session | Mean±SD | | Effect size | p-value |
|---|---|---|---|---|
| | Pretest | Post-test | | |
| 1st session | 6.45±1.08 | 10.90±1.69 | -3.16 (l) | <0.0001 |
| 2nd session | 9.61±3.24 | 11.22±1.877 | -0.57 (l) | <0.0001 |
| 3rd session | 7.09±1.68 | 9.79±1.56 | -1.65 (l) | <0.0001 |
| 4th session | 8.24±1.78 | 12.84±1.96 | -2.38 (l) | <0.0001 |
| 5th session | 7.45±1.78 | 10.08±1.62 | -1.56 (l) | <0.0001 |

**[Table/Fig-4]:** Comparison of pre and post-test scores of non BLM group.
Paired t-test was used; Effect size d=0.3 to 0.5 is small (s) 0.5 to 0.8 is medium (m) >0.8 is large (l)

Responses regarding student perception from the BLM group clearly indicate a positive perception of blended learning [Table/Fig-5]. In contrast, faculty perception responses showed that most faculty members were not comfortable delivering the ECE sessions using the BLM method [Table/Fig-6].

## DISCUSSION

Medical education has evolved from being primarily an instructor-centered process to a more student-centered approach, allowing students to learn at their own pace. Interactivity provides a means for personalised learning and reinforcement [20]. Over the last two decades, the educational landscape has rapidly changed with the development of Information and Communication Technologies (ICT). Smart classrooms, virtual classrooms, online collaborative educational experiences, and emerging Web 2.0 applications are increasingly being used, either as standalone methods or blended with conventional education [21]. Blended learning combines the best pedagogical practices of two teaching methods: online and face-to-face instruction.

In present study, there was statistical significance between the post-test scores of the two groups for several ECE sessions, with better performance from the BLM group (Sessions 1 and 3). This finding aligns with the study conducted by Wani P and Dalvi V, which showed that the integration of traditional classroom teaching with e-learning-i.e., blended learning-has a more positive impact on student performance compared to face-to-face learning [22]. In another study by Dantas AM and Kemm RE, no significant differences were found between examination marks in a new course with e-learning and the previous year without it. However, there was a significant correlation between the assessment of student e-learning work and their final examination marks [23].

In present study, student perceptions clearly indicate a positive attitude towards blended learning. A study conducted by Page J et al., found that students reported very strong positive attitude towards weekly quizzes (80% positive approval) but ambivalent feelings towards online self-directed learning (61% negative perception), despite having two-hour weekly facilitated workshops. Overwhelmingly, students who participated in the subject through self-directed online learning requested more face-to-face teaching (70% of comments). From these data, it can be suggested that there is a quantifiable benefit to didactic teaching in the blended

| S. No. | Questions/Items | Strongly disagree (1) n (%) | Disagree (2) n (%) | Neither agree nor disagree (3) n (%) | Agree (4) n (%) | Strongly agree (5) n (%) |
|---|---|---|---|---|---|---|
| 1. | I prefer BLM over non BLM for effective implementation of ECE in physiology. | 11 (20) | 4 (7.27) | 8 (14.55) | 25 (45.45) | 7 (12.73) |
| 2. | BLM helped in promoting self-directed learning in me. | 12 (21.82) | 6 (10.91) | 6 (10.91) | 23 (41.82) | 8 (14.55) |
| 3. | BLM method helped me in becoming a motivated and curious learner. | 10 (18.18) | 5 (9.09) | 9 (16.36) | 21 (38.18) | 10 (18.18) |
| 4. | BLM helped me in better and in-depth understanding of the relevance of basic medical sciences in understanding the clinical aspects. | 11 (20) | 4 (7.27) | 6 (10.91) | 22 (40) | 12 (21.82) |
| 5. | BLM sessions were well organised. | 8 (14.55) | 7 (12.73) | 12 (21.82) | 21 (38.18) | 7 (12.73) |
| 6. | BLM helped in enhancing my attention and engagement in the topic of ECE. | 11 (20) | 4 (7.27) | 8 (14.55) | 25 (45.45) | 7 (12.73) |
| 7. | The online resources of patient videos and other clinical material for Early Clinical Exposure (ECE) sessions increased my interest and provided contextual understanding of the core topic. | 9 (16.36) | 6 (10.91) | 6 (10.91) | 20 (36.36) | 14 (25.46) |
| 8. | Slow internet connectivity was a problem in BLM. | 10 (18.18) | 6 (10.91) | 14 (25.46) | 15 (27.27) | 10 (18.18) |
| 9. | BLM is confusing. | 7 (12.73) | 18 (32.73) | 20 (36.36) | 4 (7.27) | 6 (10.91) |
| 10. | Non BLM (Face to Face) method helps in better interaction between students and student-teacher. | 8 (14.55) | 15 (27.27) | 15 (27.27) | 9 (16.36) | 8 (14.55) |

**[Table/Fig-5]:** BLM group student perception responses.
How much do you agree or disagree with the following statements- *Strongly disagree=1, Disagree=2, Neither agree nor disagree=3, Agree=4, Strongly agree=5 (The questionnaire is to evaluate the perception of faculty towards BLM (combination of online and face to face learning)

| S. No. | Question | Faculty 1 | Faculty 2 | Faculty 3 | Faculty 4 |
|---|---|---|---|---|---|
| 1. | We were comfortable delivering ECE by non BLM method. | 2 | 1 | 3 | 4 |
| 2. | The preparation of online module in BLM method was tedious and time consuming. | 5 | 2 | 5 | 4 |

| | | | | | |
|---|---|---|---|---|---|
| 3. | We felt the need for more faculty to conduct effective ECE sessions by BLM methods. | 5 | 3 | 5 | 5 |
| 4. | Not all staff were willing to participate in the preparation of online modules. | 5 | 3 | 5 | 5 |
| 5. | We were not confident of using the online mode. | 5 | 1 | 3 | 4 |
| 6. | It is difficult to monitor students in BLM method. | 2 | 2 | 4 | 4 |

**[Table/Fig-6]:** Faculty perception regarding implementation of ECE by Blended learning.

learning mode that is not replicated in online self-directed learning, even when face-to-face guided inquiry-based learning is embedded in the subject [24].

The results of the meta-analyses conducted by Vallée A et al., reinforced that blended learning may have a positive effect on knowledge acquisition related to health professions [25]. In another study by Zhang X et al., it was concluded that student satisfaction was similar in both blended and traditional learning; however, blended learning had a positive effect on knowledge acquisition in physiology compared to traditional learning [26]. A study by Enoch LC et al., showed that medical students in the blended learning group performed exceptionally well in bridging the theory-practice gap across the cognitive, psychomotor, and affective clinical skills domains [27]. Research has indicated that the flipped classroom, which is a type of blended learning, is recommended for teaching evidence-based medicine courses [28].

Therefore, present study findings contribute to the growing body of research supporting the effectiveness of blended learning in physiology education, highlighting its potential to enhance student interest and motivation while addressing challenges associated with ECE modules in new curricula.

Implementing crossover designs in future studies, where students experience both blended learning and non blended learning methods in a randomised sequence, would allow for within-subject comparisons, minimising variability and providing stronger evidence of the comparative effectiveness of different teaching methods. Such studies could adopt a multicentric approach to enhance reliability. Additionally, implementing longitudinal studies would track the long-term impacts on student performance and clinical skills. Integrating advanced educational technologies and a flipped classroom model can enhance engagement and self-directed learning. Continuous professional development for educators and the creation of peer learning communities will support effective teaching. Personalised learning paths and robust student support services are crucial for accommodating diverse needs. Ongoing research and innovation hubs will identify best practices, while supportive policies and equitable access will ensure that all students benefit. Engaging parents and fostering community partnerships will further enrich the learning experience.

### Limitation(s)

The findings of the study cannot be generalised to the entire population, as it was a single-centre study. A multicentric study would yield more reliable results. The perceptions of students in the non BLM group were not assessed, and a crossover was not conducted.

## CONCLUSION(S)

Blended learning can be an effective tool for implementing early childhood education sessions in physiology. It can enhance students' self-directed learning abilities. If blended learning methods are integrated into the curriculum after five years, one can expect to see a group of motivated, enthusiastic self-learners among first-year MBBS students who can appreciate and connect the basic sciences, such as physiology, to clinical subjects.

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