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ORIGINAL RESEARCH

A Comparative Study to Enhance Medical Education in Pharmacology Through a Mobile-Based Application

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ABSTRACT

Background: Medical education is evolving rapidly. With the introduction of Competency Based Medical Education (CBME) curriculum, the need for different and innovative methods of teaching and learning is increasing. This study investigates the effectiveness of a mobile App (CBME pill) in comparison to conventional teaching methods in undergraduate pharmacology curriculum. **Methods:** It was a crossover study in which 120 voluntary second year medical students were enrolled. All were given a lecture on topic 1 and then subjected to self-directed learning session half with conventional books and others with CBME pill App. The students were then crossed over for the second topic. Performance assessments were conducted in two phases, and feedback was collected from participants. **Results:** Results indicate that students in the CBME pill App group consistently achieved higher mean assessment scores compared to those in the conventional group, with statistically significant differences observed. The positive correlation between CBME pill percentage scores and feedback scores further supports the efficacy of CBME in improving student outcomes. These findings align with existing research demonstrating the effectiveness of mobile applications and self-directed learning in medical education. Feedback from participants was overwhelmingly positive, highlighting the benefits of the CBME pill App in enhancing curriculum implementation, motivation, and engagement. **Conclusion:** This student centric teaching-learning App contribute significantly to improving student learning outcomes and engagement in Pharmacology subject. This study also highlights the transformative potential of CBME pill App in reshaping the educational journey for medical students.

Keywords: Medical education, CBME pill App, Medical students

INTRODUCTION

Over the past decade, advancements in technology have significantly impacted the e-learning domain, introducing a plethora of new devices. Smartphones and tablet computers, in particular, have revolutionized both healthcare and e-learning landscapes, enabling users to engage in learning and work activities conveniently, even while on the move. Medical students, for instance, extensively utilize mobile applications (Apps) across various facets of patient care education, encompassing history taking, examination, investigations, prescribing, and clinical management.[1,2]

Pharmacology as a subject is often perceived as a dry and volatile subject for the second year MBBS students. Academic institutions have been exploring methods to make the subject more interesting. Instead of traditional methods of teaching, efforts are being made to incorporate interactive digital technology to generate interest and participation from the students.The majority of healthcare professionals and medical students possess smartphones and use applications to learn or search for clinical information. Smartphones and high-speed internet have provided quick and ready access to medical information from leading experts in the world. Studies have suggested that mobile learning significantly improves learning.[3] The latest National Medical Commission guidelines encourage student-centric teaching and promote self-directed learning (SDL).[4]With the introduction of Competency Based Medical Education (CBME) curriculum, the need for different and innovative

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methods of teaching and learning is increasing. This study investigates the effectiveness of a mobile App (CBME pill)in comparison to conventional teaching methods in undergraduate pharmacology curriculum.
This CBME pill app is designed as a tool to generate interest in medical students and promote self-directed learning.This App is student centric teaching app developed for medical professionals. This app would be a very useful tool to both teachers and students to break the monotony of traditional theory class and promote student-teacher interaction, creating interest in practical classes. [5] The CBME pill App interface is shown in Figure 1.

Figure 1: CBME Pill App Interface

MATERIAL AND METHODS

This cross-over observationalstudy was conducted at Govt Medical College in Maharashtra. The approval for conducting this study was obtained from the Institutional Ethics Committee prior to the start of study. A total 120 second year MBBS students who volunteered were involved in this study. This study was conducted in two phases.

Phase I:

A conventional CBME-based lecture was taken on a topic from Pharmacology (Topic 1) for these MBBS students. Next, they were randomly assigned into two groups (A and B) of 60 students each. Self-directed learning (SDL) session for 1-hour duration was conducted for these students.Students in Group A were given access to the mobile-based App developed in-house by the pharmacology Dept. i.e. CBME pill App while students in Group B were having access to only standard textbooks of pharmacology. After two weeks, both groups had an assessment exam comprising of MCQs, short questions, and prescription writing based on Topic 1, using the google forms. Results was scored and recorded. After the gap of one week, the Phase 2 study was carried out.

Phase II:

A conventional CBME-based lecture was taken on another topic in Pharmacology (Topic 2) for both groups after the gap of one week. Following which SDL session was conducted and the groups were crossed. This time, group B had access to the CBME pill App while group A was havingaccess to only standard textbooks. After two weeks, both groups again had undergone an assessment exam based on the topic 2 covered in the lecture.The result score was recorded using google forms.
The flowchart of study methodology is shown in Figure 2. All the participants were subjected to a questionnaire-based feedback form to assess the acceptance of this innovative teaching/learning method. The score from 1 to 5 was given as follows: 1- Strongly Disagree, 2- Slight Disagree, 3- Neutral, 4-Agree and 5- Strongly Agree (Table VI).

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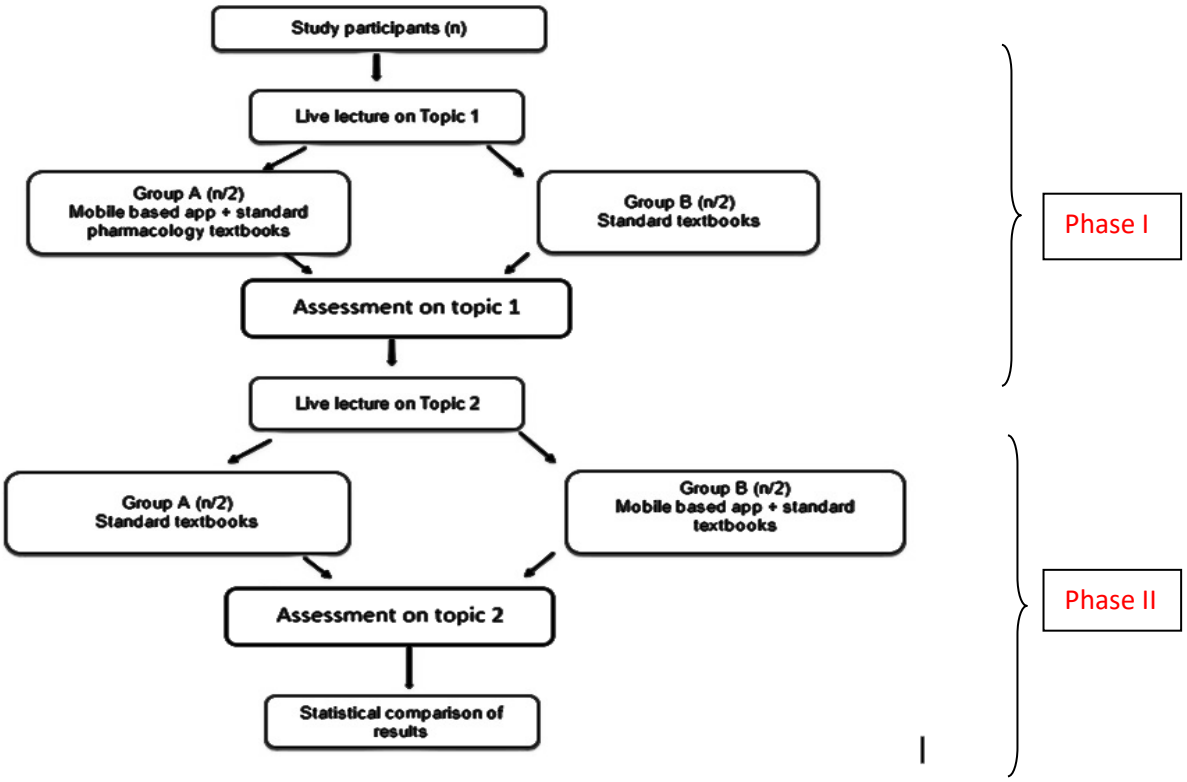
Figure 2: Flowchart of study methodology



The data obtained were entered in Microsoft excel spread sheet and evaluated. All results attained were entered in Microsoft excel and the statistical calculations were executed using Graph Pad Instat. The Pearson correlation was used to find out correlationbetween the CBME pill percentage score and the feedback scorein Phase I and Phase II.The p value less than 0.05 was considered to be statistically significant.

RESULTS

Table I and Table II are depicting average comparison of Phase I and Phase II percentage score between CBME pill App and Conventional Group, respectively. The mean percentage score for the CBME pillApp group during Phase I was 83.67±14.35, while the mean percentage score for the Conventional group was 75.33±24.63. The difference in scores was statistically significant (P=0.025). The mean percentage score for the CBME pill App group during Phase II was 91.74±8.67, whereas the mean percentage score for the Conventional group was 63.49±16.63. This difference was highly significant (P<0.0001).

Table No I: Average comparison of Period 1 percentage score between CBME and Conventional Group.

Group	Score period 1 (%)		
	Mean	SD	P Value
CBME (N=60)	83.67	14.35	0.025
Conventional (N=60)	75.33	24.63	
Total	73.78	22.04	

Table No II: Average comparison of Period 2 percentage score between CBME and Conventional Group.

Group	Score period 2 %		
	Mean	SD	P Value
CBME (N=60)	91.74	8.67	<0.0001
Conventional (N=60)	63.49	16.63	
Total	77.61	19.38	

The comparison of average scores of performance in Phase I of the CBME pill App group to conventional group in Phase IIreveals a significant decline (Table III). In CBME pill App, the mean score was 83.67 ±

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14.35. However, in conventional group, the mean score dropped to 63.49 ± 16.63. This decrease in scores is statistically significant, as indicated by a P-value of less than 0.0001. Table IV shows the comparison of average scores of performancein Phase I of conventional group to CBME Pill App group in Phase II. This scorereveals a significant improvement. In conventional group, the mean score was 75.33 ± 24.63. However, CBME pill App group, the mean score increased to 91.74 ± 8.67. This increase in scores is statistically significant, as indicated by a P-value of less than 0.0001.

Table No III: Comparison of average Scores in Group A students from Phase I to Phase II

First Batch Scores (N=60)	Intervention	Mean	SD	P Value
Period 1	CBME	83.67	14.35	<0.0001
Period 2	Conventional	63.49	16.63	

Table No IV: Comparison of average Scores in Group B students from Phase I to Phase II

2nd Batch Scores (N=60)	Intervention	Mean	SD	P Value
Period 1	Conventional	75.33	24.63	<0.0001
Period 2	CBME	91.74	8.67	

Table V is depicting the correlations of CBME pill App percentage score in Phase I and Phase II with feedback score.The Pearson correlation between the CBME Pill App percentage score in Phase I and the feedback score was 0.234 (P=0.03), indicating a significant positive correlation at the 0.05 level. The Pearson correlation between the CBME pill App percentage score in Phase II and the feedback score was 0.35 (P<0.001), indicating a highly significant positive correlation at the 0.01 level.

Table No V: Correlations of CBME pill percentage score in Phase I and Phase II with feedback score.

Correlations		CBME bill score period 1	CBME bill score period 2
Feedback score	Pearson Correlation	0.234*	0.35**
	P Value	0.03	<0.001
	N	60	60
* Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).			

After the conclusion of both phases, a questionnaire-based feedback regarding the acceptability and features of the CBME pill App was taken from all the participants (Table VI). In this study, students agreed to strongly agreed (mean score 4.28) that the quick recap after theory class was beneficial. They also agreed to strongly agreed (mean score 4.23) that practical sessions helped to break monotony. Delivering tutorials effectively received an average score of 4.01 (agree). Self-directed learning for undergraduates received an average score of 4.02 (agree). Integrating topics both horizontally and vertically received a neutral to agree score of 3.67. Live feedback to improve motivation received an average score of 4.01 (agree). The implementation of CBME to enhance the curriculum was rated agree to strongly agree with an average score of 4.34. Using the teaching tool as a PowerPoint add-on was rated agree with an average score of 4.02. Prescription scenarios to improve memory received an average score of 4.01 (agree). Concept matching to engage students had received a neutral to agree score of 3.85.

Table VI: Feedback from Students about CBME pill App Features

Feedback about CBME pill app features	Average Score*	Interpretation
1. Quick Recap - After theory class	4.28	Agree to strongly agree
2. Break Monotony - Practical sessions	4.01	Agree to strongly agree
3. Deliver Tutorials - Effectively use	4.02	Agree
4. Self-Directed Learning - For undergraduates	4.18	Agree
5. Integrate Topics - Horizontal and vertical	3.67	Neutral to agree
6. Live Feedback - Improve motivation	4.01	Agree
7. CBME Implementation - Enhance curriculum	4.34	Agree to strongly agree
8. Teaching Tool - PowerPoint add-on	4.02	Agree
9. Prescription Scenarios - Improve memory	4.01	Agree
10. Concept Matching - Student engagement	3.85	Neutral to agree
* Score is calculated as 1- Strongly Disagree, 2- Slight Disagree, 3- Neutral, 4-Agree and 5- Strongly Agree		

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DISCUSSION

The present study showed that the CBME pill App group had higher mean performance scores compared to the Conventional group in both Phase I and Phase II, with statistically significant differences. This indicates that the implementation of CBME pill App was effective in enhancing student performance. The positive correlation between the CBME bill percentage scores and the feedback scores further supports the success of CBME in improving student outcomes. One-way to interpret these results is that the structured and competency-based approach of CBME, along with tools such as quick recaps, practical sessions, and self-directed learning, positively impacted student learning and engagement.Feedback from the participants was encouraging with suggestions and no negative feedback was received.

A systematic review and meta-analysis was done on mobile applications in medical education by Chandran VP et all in 2022. After analyzing 52 studies, the authors concluded that mobile applications are effective tools in enhancing knowledge and skills among healthcare professionals. Online/offline and android/iOS based applications were equally effective in enhancing knowledge.[6]Singh K et al carried out a study smartphones and educational apps use among first and second year MBBS students. This study found that smartphones and related medical education apps are widely used by medical students and improve their educational experiences. Authors have also suggested that universities should develop policieson usage of smartphone for academic purposes. [7]A systematic review was carried out by Murad MH et al on effectiveness of SDL in health professions education. This article reviewed 59 studies and concluded that SDL in health professions educationis associated with moderate improvementin the knowledge domain compared withtraditional teaching methods and may beas effective in the skills and attitudes domains.[8]The present study well aligns with above studies.

This study received positive and encouraging feedback including the breaking the monotony of session, enhancing implementation of CBME curriculum and improving motivation about the CBME pill App. A user centered approach study was done by a mobile application for health professionals and this study showed a significant usability and acceptability of this mobile application, in terms of effectiveness, efficiency, and satisfaction. [9] One limitation of this study is the relatively short duration of the assessment periods, which may not fully capture the long-term impact of the CBME pill App on student learning outcomes. Also only two topics from the pharmacology were included in this study and outcome may differ depending on the difficulty level of topic.

In conclusion, the findings of this study suggest that the structured and competency-based approach facilitated by the CBME pill App, along with its accompanying features such as quick recaps, practical sessions, and self-directed learning, contribute significantly to improving student learning outcomes and engagement in pharmacology subject. These results highlight the importance of integrating technology-driven solutions in medical curriculum to engage medical students in various subjects.This will create rich and impactful educational environment. Further research is warranted to explore long-term outcomes and scalability of such interventions.

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