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Research Article

The Effectiveness of a Novel Android Application for Improving Deep Learning Approach Among Medical Students: A Randomized Control Trial

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ABSTRACT

Background: Biggs defined learning approaches as the combination of motivation and strategy that students employ while studying, which might be "Surface" or "Deep". The Deep Learning technique entails the ability to connect new and old knowledge, the capacity to study thoroughly to get a "whole picture," and the skill to seek meaning and implications in what you have learned. The objective was to determine the effectiveness of an app-based intervention on improving Deep Learning approach among medical students. **Methodology:** A parallel-group, unblinded, Randomized Control Trial was conducted among the MBBS undergraduate students of a medical college in South India, using an android app based digital intervention. The Intervention Group was given the application for free that sends information and strategies for imparting Deep Learning approach daily for six weeks, followed by the assessment using the and assessed using R-SPQ-2F questionnaire in both groups. **Result:** Out of 140 participants, a highly significant ($p<0.001$) improvement of the mean Deep Motive score was observed in the Intervention group, after using the app, whereas the control group observed a significant reduction in their scores, which was statistically significant ($p<0.001$). The Deep Approach Score was also improved in the intervention group ($p<0.001$), whereas it declined over time in the control group. There was no significant association between sleep duration and learning approach. Overall, the use of the app reflected a statistically significant improvement in all three domains of Deep learning, such as Deep Motive, Deep Strategy, and Deep Approach in the Intervention group. **Conclusion:** The intervention by the android application effectively imparted a Deep Learning Approach among medical students, with statistically significant improvements.

INTRODUCTION

The Marton and Säljö theory of student learning approaches posits that knowledge is best built within the personal cognitive structures of individual students[1]. This theory has led to the development of the constructivism concept, which emphasises the importance of experiences and social interactions in the learning process[2]. The most successful students participate meta-cognitively, with motivation and dynamic behaviour[3, 4]. It is well established that the type of student learning in each subject is affected by personal and contextual factors, teaching context and cultural backgrounds. Therefore, it is vital to maximise students' learning performances by locating those modifiable factors upon which we can act[5, 6].

Biggs defined learning approaches as the combination of motivation and strategy that students employ while studying, which might be "Surface" or "Deep"[7]. The Deep Learning technique entails the ability to connect new and old knowledge, the capacity to study thor-ughly to get a "whole picture," and the skill to seek meaning and implications in what you've learned. On the other hand, the Surface Learning approach is one in which students pick the quickest method to complete a task and study the information linearly, with no in-depth inquiries, poor interest in the topic, or reliance on memory instead of comprehension[8].

Surface Learning is typically characterised as memorising facts and main points without understanding the underlying concepts[9]. In contrast, Deep Learning involves understanding the concepts and ideas behind the information and linking them to other knowledge. Surface Learning is measured in terms of Surface Approach, Surface Strategy and Surface Motive, which are characterised by extrinsic responsibility, lack of reflection and memorisation[10]. Deep Learning goes beyond just acquiring knowledge and skills. form of constructivist learning accentuates the prior knowledge of the students and can help them understand new content and skills[11].

Strategy and Deep Motive, and pursues reflections on meaning and comprehension, with an intrinsic responsibility[12, 13].

It has been observed in previous studies that strategies such as strength-based feedback, constant reflection, modelling, co-construction, developing a growth mindset, and tiered learning targets can strengthen Deep Learning among medical students[14]. Readily available technology like mobile phones and tablets to enhance Deep Learning is conceivable for implementing these strategies among college students. However, there are no studies to date that measure the effectiveness of app-based interventions using these principles to improve Deep Learning among medical students; hence, this study was proposed.

Aim: To assess the effectiveness of a novel Android application for improving Deep Learning approach among medical students.

Objective: To determine the effectiveness of an app-based intervention on improving Deep. To determine the association of Deep Learning with the duration of sleep. Learning approaches among medical students.

MATERIALS AND METHODS

a) Study Design: Parallel group, unblinded, Randomized Control Trial, with a waitlist control group. Participants will be individually randomized in a 1:1 ratio

b) Study Setting: MBBS undergraduate students of a medical college in South India,

c) Inclusion Criteria

Participants who satisfy all these four criteria are selected for the study

· Undergraduate medical students from the institution, where the study is conducted

· Own an android device (either phone or a tablet)

· Willing to install and use the study app for 15 minutes every day for 6 weeks

· Willing to give informed written consent to take part in the study

d) Exclusion Criteria

· Undergraduate students having only iOS devices with them

e) Sample size: 55 students in each group

f) Study duration: 8 weeks

1.1. Study Instrument

A validated instrument called the Revised two-factor version of the Study Process Questionnaire (R-SPQ-2F), developed by Biggs et al. was used for the study [7]. It consisted of two 10-item scales in a Likert format, which was further subdivided into: Deep Motive, Deep Strategy, Deep Approach, Surface Motive, Surface Strategy and Surface Approach. The responses were coded as 1 = "never" to 5 = "always or almost always" and the results ranged from 10 to 50 points for each scale. The "deep approach" scale score was based on the sum of the Deep Strategy, Deep Motivation and Deep Approach subscales, and higher scores denote the use of a deeper approach.

1.2. Randomization and Allocation

Students who met the study criteria were given an information letter and the consent form. They were informed that withdrawal from the study was possible at any time, and all collected case data can be deleted on request. Those who submitted the consent form were then invited to fill out the baseline assessment (Assessment 1).

The participants had undergone batch-wise stratified randomization by the principal investigator. Random numbers were generated by the study guide using a computer-based random number generator (Randlist). Based on this, participants within each batch were allocated to either the Intervention Group (IG) or the Wait-list Control Group (WCG), in a 1:1 ratio (55 each). Principal investigator emailed a link to download the app to the IG.

1.3. Intervention

An android app was developed by the researchers based on Deep Learning techniques like strength-based feedback, constant reflection, modelling, co-construction, developing a growth mindset, and tiered learning targets. Participants in the IG were able to download the app from the emailed link and use all its features free of charge. Information and strategies for imparting the Deep Learning approach were be sent to the IG participants on a daily basis, for a period of 6 weeks. A second assessment (Assessment 2) was done for both the IG and WCG, after the end of 6 weeks, using the R-SPQ-2F questionnaire. Those students in the wait-list group were able to download the app and received the same information for the next 6 weeks, after this assessment.

RESULTS

a) Descriptive Statistics

Out of 140 participants, 77 (55%) were females, and 63 (45%) were males, with the mean age of participants in both groups being 22.1 ± 1.1 years. The majority of students in both groups had an average mobile usage of 3-6 hours per day (62.9%), out of which less than 1 hour was used for educational purposes. Only 37% of students in the intervention group and 42.9% in the control group had more than six hours of sleep per day. The Chi-square test and independent sample t-test were performed to check if there was any difference in the distribution of baseline characteristics between the experimental and control group. No statistically significant difference was observed between both groups.

In baseline assessment 1 (Pretest), the mean score for the Deep approach and Surface approach were 26.46 (SD=6.06) and 24.47 (SD=5.98), respectively. Year 1 students had the highest mean score for the Deep Learning approach (27.6 out of 50), and the Year 2 students had the lowest (24.1 out of 50), as described in **Table 1.**

personal connection. The subject's necessities are attained with minimal effort from the students' side through This Deep Learning is measured by Deep Approach, Deep

Table 1: Distribution of the assessment 1 (pre-test) scores of deep and surface learning approaches between the year of study participants (n = 140)

	N	Mean	SD
Deep Learning Approach (10-50)*			
Year 1	34	27.6	3.49
Year 2	36	24.1	5.75
Year 3	70	27.1	3.5
Surface Learning Approach (10-50)*			
Year 1	34	25.9	5.6
Year 2	36	24.9	5.7
Year 3	70	23.8	5.6

*The possible range for the deep or surface approach

a) Results of Objective 1

Two-way repeated measures mixed ANOVA was performed to determine any significant differences in the average of Deep Strategy, Deep Motive, Deep Approach, Surface Strategy, Surface Motive, and Surface Approach scores before and after the intervention, within and between the groups.

A significant ($p<0.001$) improvement of the mean Deep Motive score was observed in the Intervention group after using the app, as represented in **table 2.** However, this improvement was not observed in the control group, which highlights the app's effectiveness in improving the students' Deep Motive **(figure 1).** This improvement was statistically significant between the groups ($p<0.001$).

A significant reduction in the Deep Strategy score was observed in the control group during the six-week follow-up period. However, using the app in the intervention group prevented this decline, and the difference was statistically significant between the two groups ($p<0.001$). The Deep Approach Score was also improved in the intervention group ($p<0.001$), whereas it declined over time in the control group **(figure 2).** Meanwhile, Surface Learning domains such as Surface Motive, Surface Strategy, and Surface Approach have increased over time in the Control Group, which is an undesirable learning approach among medical students. On the other hand, the use of the app has prevented such an increase in Surface Learning scores in the intervention group, and the difference was statistically significant between the two groups ($p=0.002$).

Table 2: Difference in mean scores of Deep Motive, Deep Strategy, Deep Approach, Surface Motive, Surface Strategy and Surface Approach, before and after the intervention (n = 140)

Variable	Group	Tests	Mean (SD)	Within group F(pvalue)	Between groups F(p-value)
Deep Motive	IG	Pretest	13.47(2.95)	11.54 (<0.001**)	12.19 (<0.001**)
		Post test	15.17(3.34)		
	CG	Pretest	13.67(3.50)	2.37 (0.125)	
		Post test	12.90(3.31)		
Deep Strategy	IG	Pretest	12.94(3.05)	1.422 (0.235)	31.19 (<0.001**)
		Post test	13.59(3.84)		
	CG	Pretest	12.83(3.75)	44.96 (<0.001**)	
		Post test	9.21(2.41)		
Deep Approach	IG	Pretest	26.41(5.42)	5.61 (0.019**)	25.83 (<0.001**)
		Post test	28.57(6.38)		
	CG	Pretest	26.50(6.68)	23.21 (<0.001**)	
		Post test	22.11(5.07)		
Surface Motive	IG	Pretest	10.63(3.23)	0.77 (0.38)	1.20 (0.275)
		Post test	10.14(2.74)		
	CG	Pretest	11.63(3.77)	0.45 (0.50)	
		Post test	12.00(3.31		
Surface Strategy	IG	Pretest	13.24(3.09)	8.45 (0.004**)	5.23 (0.024**)
		Post test	11.84(3.06)		
	CG	Pretest	13.44(3.23)	0.11 (0.745)	
		Post test	13.60(3.03)		
Surface approach	IG	Pretest	23.87(5.57)	4.38 (0.038**)	3.59 (0.06)
		Post test	21.99(4.75)		
	CG	Pretest	25.07(6.36)	0.34 (0.558)	
		Post test	25.60(5.60)		

**significant ($p<0.05$). #IG- Intervention group, CG- Control group.

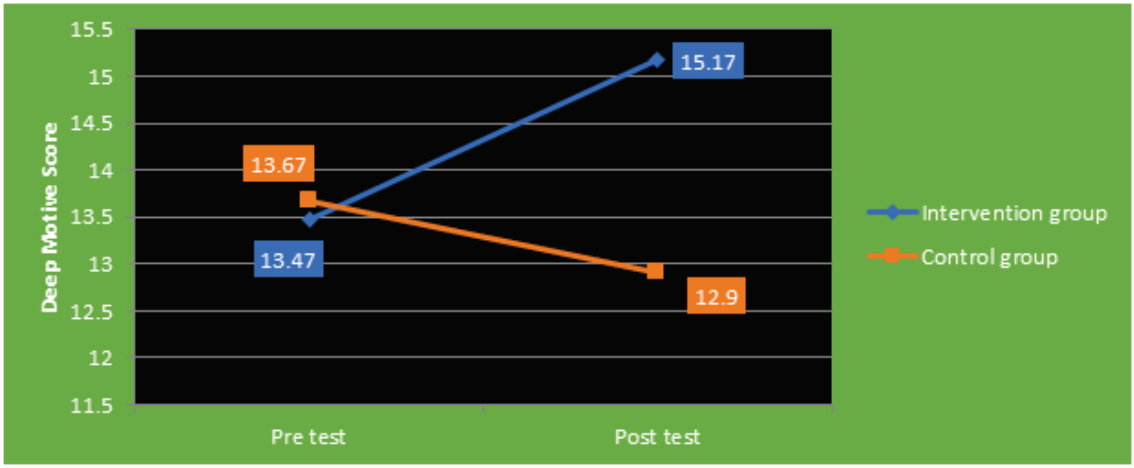

Figure 1: Graphical representation of difference in mean scores of Deep Motive in pre and post tests

Figure 2: Graphical representation of difference in mean scores of Deep Approach in pre and post tests

a) Results of Objective 2

The independent sample t-test was performed to determine the association of Deep Learning with the duration of sleep per day. There was no significant association between the duration of sleep and the surface and Deep Learning scores were observed.

DISCUSSION

In the present study, the mean age of participants was 22.1 ± 1.1 years in both groups. However, in a similar study conducted in Nepal among medical, dental, and nursing students by Shah et al., the mean age was 19.8 ± 1.3years, as most participants were first-year students[14].

When the learning approach of medical students was compared according to the year of study, 24.3% were from Year 1 (deep approach =27.56), 25.7% from Year 2 (deep approach=24.09), and the highest (50%) were from Year 3 (deep approach=27.06). While in another study by Tiwari et al. among nursing students, the highest number of participants were from Year 1 (36.9%) (deep approach=27.7), followed by 30.5% from Year 2 (deep approach=29.0), 25.1% from Year 3(deep approach=30.4) and 7.5% from Year 4 (deep approach=29.4) [21].

Gijbels et.al showed that female gender [Mean=2.43, SD=0.53, F (1,129) = 12.03, $p<0.01$] and age had a significant association with Deep Learning approach[17]. However, such an association was not observed in the present study. This difference might be because the former study was conducted among law school students, while our study was among medical students.

The present study revealed that Deep Motive, Deep Strategy, and Deep Approach scores were significantly improved in the intervention group. In contrast, the undesirable Surface Learning scores were increased in the control group. Overall, the use of the app reflected a statistically significant improvement in all three domains of Deep learning, such as Deep Motive, Deep Strategy, and Deep Approach in the Intervention group. This could be due to increased awareness of the new deep strategies provided in the android application to the intervention group, which was available on a daily basis. In the randomized control trial by Tiwari et al. among nursing students, the intervention of problem-based learning was used to develop such Deep Learning behavior[21]. However, a statistically significant improvement was not obtained in that study. The possible reason for the significant improvement in the present study could be the

use of the android app as the intervention, which is more feasible and acceptable for the students to access the information at any time, thereby increasing its effectiveness.

It was also observed that 60% of the participants of the present study had only 4-6 hours of sleep per day. However, a statistically significant association between the duration of sleep and the type of learning approach was not obtained. On the contrary, the study by Delgardo et al. observed a significant association that the students having a higher surface approach tend to have a poor quality of sleep (53.4%) [18]. This difference in results between the two studies might be due to a lack of information about the sleep pattern, like the duration of sleep before exams which was not assessed in the present study.

CONCLUSION

Overall, the intervention by the android application was significantly effective in imparting the Deep Learning Approach among medical students. It also effectively prevented the development of undesirable Surface Learning behavior among these students. It has also demonstrated that constant motivation about Deep Learning and awareness about learning strategies can improve the Deep Learning approach among the students. Hence, the present study recommends this android application globally as a cost-effective and acceptable intervention for improving the learning skills, which are quintessential for medical students.

CONFLICT OF INTEREST

There is no conflict of interest

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ETHICS APPROVAL

All necessary approval including ethical approval has been taken from the Institutional Human Ethics Committee before conducting this study.

CONSENT FOR PUBLICATION

All necessary consent for publication was obtained by authors.

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