



## Use of concept map as a reinforcement tool in undergraduate curriculum: an analytical study

KAUSHIK MUKHOPADHYAY<sup>1</sup>, SONALI MUKHERJEE<sup>1</sup>, ARCHANA DHOK<sup>2</sup>,  
CHANDAN CHATTERJEE<sup>1</sup>, JOYA GHOSH<sup>1\*</sup>

<sup>1</sup>Department of Pharmacology, ESIC Medical College, 23 Diamond Harbor Road, Joka, Kolkata, India; <sup>2</sup>Department of Biochemistry, JNMC, Wardha, India

### Abstract

**Introduction:** Ever-expanding medical literature demands successful amalgamation of huge information and clinical practice for budding doctors. This study aimed to find the effectiveness of the concept map, a novel method of teaching to improve performance among undergraduate pharmacology students.

**Methods:** The undergraduate medical students pursuing pharmacology in 2017-18 in our institute was divided into two groups after stratified randomization based on the last semester grades. After a session of didactic lecture on 'Drugs affecting Calcium Metabolism' and a pre-test, one group was taught using traditional tutorial methods and another group using the concept map method. Finally, a post-test was taken and feedback received from the intervention group.

**Results:** A significant improvement of student performance was found in both groups using validated questionnaire from pre-test to post-test. There was no significant difference in the percentage of improvement between the groups. This finding was consistent in both Low scorers and High scorers of the previous semester examination. Students found the new method better in terms of understanding the concept and interactivity.

**Conclusion:** Concept mapping encourages the students to actively participate and get a comprehensive and accurate overview of the topic, but the improvement in performance in the test was not evident.

**Keywords:** Concept map, Medical teaching, Feedback, Curriculum

### \*Corresponding author:

Joya Ghosh  
Department of Biochemistry,  
ESIC Medical College,  
23 Diamond Harbor Road,  
Joka, Kolkata – 700104  
**Tel:** +91 8100021634  
**Email:** joya\_ghosh@yahoo.com

Please cite this paper as:  
Mukhopadhyay K, Mukherjee S, Dhok A, Chatterjee C, Ghosh J. Use of concept map as a reinforcement tool in undergraduate curriculum: an analytical study. J Adv Med Educ Prof. 2019;7(3):118-122. DOI: 10.30476/JAMP.2019.74920.

Received: 3 December 2018  
Accepted: 3 May 2019

### Introduction

Successful integration of theory and practice is the holy grail of medical teaching. Students often find it difficult to cope with the cognitive as well as psychomotor aspects of ever-expanding medical sciences. Thus, teaching methods need to be more systematic to assimilate the acquired information with practical application. A meta-analysis was conducted by Vishram Singh et al. to see the effectiveness of various instructional modalities of teaching and learning of anatomy. They have seen in many studies

that didactic lectures promote passive learning and it is not a student-centered teaching. To overcome this, it has been suggested that more activities, should be included in the lectures to encourage active learning (1). Saulnier et al. have pointed out that placing students at the center of instruction shifts the focus from teacher to learner, encouraging metacognitive development necessary for learners to become self-dependent as well as thinkers (2). A study by Dinarvand et al. has shown how the use of self-made concept maps prepared by the 2<sup>nd</sup> year

MBBS students as assignment helped them to learn classroom material more effectively (3). In this study, concept maps were not being used by the facilitators as a mode to reinforcement of knowledge given in lectures. Concept map is a sort of pictorial organizer used to assist the pupils arrange, assemble, and represent understanding of a subject. Concept map starts with a principal idea (concept) and then develops to demonstrate how that elemental plan can be divided into specific topics (4). In a study conducted in the department of biochemistry, we found a relative gain of knowledge in low scorers after teaching by concept mapping (5). This project has been taken to show if the same mode of teaching can be adopted along with the traditional method to enhance understanding of more clinically oriented subjects in a group of medical students.

The primary objective was to study the effectiveness of concept map as a reinforcement tool in medical teaching along with didactic lectures in comparison to the usual tutorial method. We also aimed to find the students' perception towards this novel method of teaching.

## Methods

### Study site

This prospective interventional study was performed in the Department of Pharmacology, ESI-PGIMS & ESIC Medical College, Joka, Kolkata on the 5th Semester UG medical students (MBBS - Bachelor of Medicine, Bachelor of Surgery) from October 2018 to December 2018 after approval of the Institutional Ethics Committee.

### Inclusion and exclusion criteria

All the 5<sup>th</sup> semester students who were willing to participate and gave written informed consent participated in the study. Students who were unwilling to participate or were absent on initial didactic lecture and pre-test were excluded from the study.

### Stratified randomization

Non-probability convenient sampling method was used to collect the data. This was followed by stratified randomization of all subjects based on previous performance. Figure 1 shows the study design. Batch of 79 students was divided into Low Scorer (<50%) and High Scorer ( $\geq$ 50%) based on the 4<sup>th</sup> semester scores.

This two groups were further randomized into 2 subgroups (simple randomization). The whole process made four subgroups - A, B, C and D where A and C was from the Low Scorer group and B and D from High Scorer group.

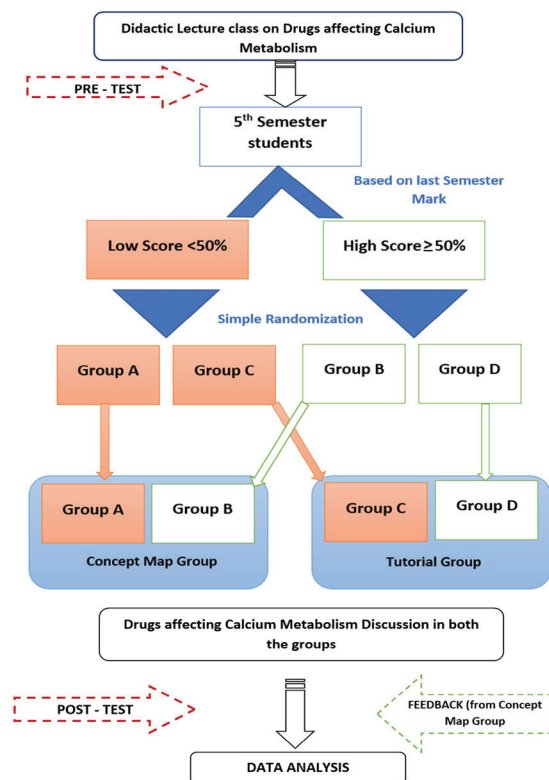


Figure 1: Flow diagram of the study design

### Educational intervention

Initially, a didactic lecture session on 'Drugs affecting Calcium Metabolism' was delivered to all the students. Then, groups A and B were taught by i.e. concept map method and groups C and D by the traditional tutorial method. The concept map was prepared in consultation with other departments like General Medicine and Biochemistry.

### Outcome measurement

A structured questionnaire was designed, validated (in-house), and used to assess the performance of the students (consisting of MCQ and Short Answer Type Questions on drugs affecting calcium metabolism) before and after the intervention. The validity of the questionnaire was checked by qualitative research experts from another institute. The 14 day (two-week) test-retest reliability was checked in an initial group of 20 students. These students were not included in the study. Cronbach's alpha was used to check the reliability of the questionnaire during the initial validation. Perception of the participants was assessed through a feedback form for the group exposed to concept mapping.

### Analysis plan

Students who participated in all the steps of the study were included in the analysis.

All statistical analyses (Shapiro Wilk Test for Normality, Unpaired t-tests / Wilcoxon rank sum, Wilcoxon signed rank test) were carried out by R version 3.5.1 and R Studio version 1.0.136 (R foundation) statistical software (Language).  $p < 0.05$  was considered as statistically significant.

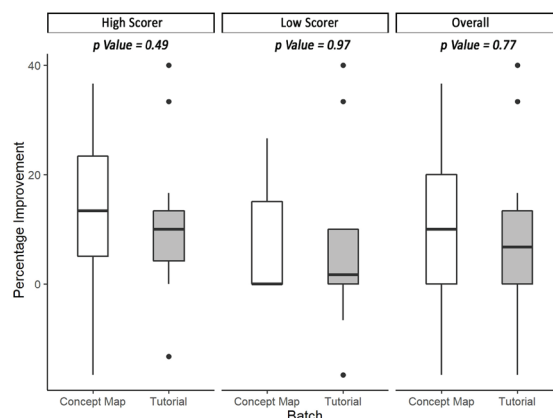
**Results**

75 students participated in the study. Of the 75 students, 27 missed the pre-test, intervention session, or post-test. Therefore, they were excluded from the study. We analyzed the data of 48 students (Concept map group=22, Tutorial Group=26).

As shown in Table 1, concept map or conventional tutorial had no statistically significant bearing as the better method of teaching learning on their semester examination or periodical assessment. Baseline performance of those two groups ( $p=0.9866$ ) was compared using unpaired t-test. The same result was obtained while comparing pre-test score ( $p=0.3143$ , Wilcoxon rank sum test) and post-test score ( $p\text{-value}=0.8682$ , Wilcoxon rank sum test) between the groups. However, improvement in the percentage of the median score was seen more in the concept map group than the conventional tutorial ( $p=0.7689$ , Wilcoxon rank sum test) one.

On the other hand, there was a statistically significant performance improvement in the post-test score (after intervention) using Wilcoxon signed rank test in both groups. The result is displayed in Table 2.

Figure 2 shows improvement in performance among the high and low Scorers in both groups. Low Scorer Concept Map (Batch A from Figure 1) and Low Scorer Tutorial (Batch C from Figure 1) group showed very little improvement ( $p=0.974$ , Wilcoxon rank sum test).



**Figure 2:** Box and whisker plot showing distribution of improvement of performance in high scorers and low scorers in both concept map and tutorial groups

On the contrary, both High Scorer Concept map (Batch B from Figure 1) and High Scorer Tutorial (Batch D from Figure 1) groups showed improved performance, but there was no significant difference between them ( $p=0.4913$ , Wilcoxon rank sum test).

Students’ perception regarding concept map is shown in Table 3. More than 90% students agreed that it was a better method of teaching and it contributed to a thorough understanding of the topic. All of them felt involved in this teaching-learning method although they suggested time constraint was a major challenge.

During initial validation, Cronbach’s alpha was used to assess the reliability of the questionnaire on a sample of 20 students. We found a value of 0.765 for pre-test and 0.801 for post-test questionnaire indicated good reliability.

**Discussion**

Pharmacology curriculum demands a lot of knowledge to be gathered. Students often try

**Table 1:** Performance in tests by the concept map and tutorial groups

	Concept map group (A+B) [n=22]	Tutorial group (C+D) [n=26]	p-value
Last semester percentage mean (SD)	48.37 (13.71)	48.30 (14.69)	0.9866
Pre-test percentage median (IQR)	50 (22.49)	55 (26.67)	0.3143
Post-test percentage median (IQR)	65.00 (35.00)	66.67 (19.16)	0.8682
Improvement in Percentage median (IQR)	10.00 (20.00)	6.67 (13.33)	0.7689

**Table 2:** Improvement of scores in both concept map and tutorial groups

	Pre-test score in percentage – median (IQR)	Post-test score in percentage – median (IQR)	p-value
Concept map group (A+B)	50 (22.49)	65.00 (35.00)	0.0046
Tutorial group (C+D)	55 (26.67)	66.67 (19.16)	0.0078

**Table 3:** Students' opinion about concept map method of teaching

Type of question	Questions	Response
Close ended	The newer method of teaching was good in comparison with traditional method	Strongly Agree – 44% Agree – 48% Disagree – 8%
	It helped better retention of the knowledge as compared to the older method	Strongly Agree – 48% Agree – 40% Disagree – 12%
	Able to understand the concept of the disease condition with respect to its sign symptoms, diagnosis, and management as compared to the didactic lecture	Strongly Agree – 40% Agree – 60% Disagree – 0%
	Method made you feel more involved in the whole process of learning	Yes – 100% No – 0%
	Explanation was thorough	Yes – 76% No – 24%
Open ended	What is it about this technique that impressed you the most?	1. Helpful in understanding the topic 2. Good for quick review 3. Clarification of misconception 4. Better interaction with teacher and fellow students during built up
	What are major disadvantages of this technique?	1. Takes more time than traditional method 2. Only small areas can be covered at a time 3. Not good for preparation for tests

to memorize it without deep understanding. It poses a big challenge for teachers to encourage every student to visualize the greater picture and perceive the subject as the bridge between pre-clinical subjects like Physiology or Biochemistry and clinical subjects. That would enable them to use their theoretical knowledge into practice at patient bedside. A teaching-learning tool like concept map can be useful in this scenario. i.e. concept maps motivate innovation as each map is distinctive and sheds light on the rational judgement of the planner. In 1968, David Ausubel introduced the idea of concept map in his book 'Educational Psychology: A Cognitive View' on assimilation theory of learning (6). The potential of concept map as a teaching method was explored in detail by the psychology educator Joseph Novak (7). It is a technique of visual representation of informational structure that describes the way in which the concepts interact in a given field. Positive impact of the concept map in medical students has been reported in many studies (8, 9). Surapaneni et al. successfully used the concept map to promote academic achievement of the first year medical students in Biochemistry. Pupils in this novel approach using concept mapping outclassed those in the traditional didactic lecture program (means of 7.13-8.28 vs. 12.33-13.93,  $p < 0.001$ ) (10). Similar findings were also reported by Kwas et al. among a group of interns (11). West et al. show it as a method which enables critical thinking among resident physicians (4). However, in our study, students have not shown statistically better performance with concept map than the

tutorial method ( $p$ -value=0.7689). Smaller sample size and higher drop-out rate (27 out of 75) might be a factor which accounts for such findings. Similar performance was observed by Qadir et al. They could not find a change in the performance while teaching pharmacology using this method in a group of dental students (12). Baig et al. has shown a significant difference in the scores obtained in problem-solving questions in a class taught by i.e. concept map as compared to those subjects who were taught using the conventional lectures ( $p < 0.001$ ). A significant difference was not found in the scores of declarative knowledge questions ( $p = 0.704$ ) by the same individual (13).

Hsu et al. conducted a randomized comparative study to prove that outcome-based concept mapping is a valuable educational method which could encourage a group of nursing students to take a bio-psycho-social approach to medicine although they did not find any significant improvement in performance (14). In this study, also, the academic outcome in terms of obtained marks was similar in both traditional teaching and interventional groups. Some studies have found that this method is mostly helpful for the students with poor grades (5, 13). However in our study, students with better grade showed performance improvement with concept map although it was not statistically significant [10.00 (20.00) compared to 6.67 (13.33),  $p$ -value 0.7689].

An comprehensive literature search provides mixed results on the concept map for performance improvement when measured by traditional assessment tools like MCQ, Short

Answer Type Question etc. Many studies have found a positive impact, whereas others report no significant advantage. However, active student participation and positive feedback from learners were a consistent finding in most of the studies (5, 10, 13-15). In our study, qualitative analysis suggested that the intervention increased the students' motivation, helped them clarify the suspicions, and developed a better attitude to participate actively in academic discussion.

### Conclusion

Students found that concept maps enhanced their capacity to get a comprehensive and accurate overview of the entire topic. It is an excellent choice as a reinforcement tool reflecting the performance score but has not shown better performance than traditional tutorial (didactic lecture) method statistically. It could have changed with a larger sample size. Therefore, this type of project should be continued for few consecutive years with a better sample size.

### Limitation

The study was conducted with a single batch of students and discussion was based on a single topic. A larger group of students with a series of similar concept map sessions is required to confirm the findings.

**Conflict of Interest:** None declared.

### References

1. Singh V, Kharb P. A paradigm shift from teaching to learning gross anatomy: meta-analysis of implications for instructional methods. *J Anat Soc India*. 2013;62(1):84–9.
2. Saulnier BM. From “Sage on the Stage” to “Guide on the Side” Revisited: (Un)Covering the Content in the Learner-Centered Information Systems Course. *Inf Syst Educ J*. 2009;7(60).
3. Dinarvand G, Vaisi-raygani A. Brief Communication The Effect of Task-based Teaching via Drawing the Concept Map of Metabolic Pathways as Homework on the Academic Achievement of Pharmaceutical Students in Biochemistry Course. *Educ Res Med Sci*. 2013;2(1):26–8.
4. West DC, Pomeroy JR, Park JK, Gerstenberger EA, Sandoval J. Critical thinking in graduate medical education: A role for concept mapping assessment? *JAMA*. 2000;284(9):1105–10.
5. Ghosh J, Pradhan RVS. Concept map as a reinforcement method of teaching biochemistry. *Indian J Basic Appl Med Res*. 2016;5(3):659–66.
6. Ausubel DP. *Educational Psychology: A Cognitive View*. US: Holt, Rinehart and Winston; 1968.
7. Novak JD, Gowin DB. *Learning how to learn*. New York: Cambridge University Press; 1984.
8. Daley BJ, Torre DM. Concept maps in medical education: An analytical literature review. *Med Educ*. 2010;44(5):440–8.
9. Canas AJ, Coffey JW, Hoffman RRR, Novak JDJD, Cañas AJ, Carnot MJ, et al. A Summary of Literature Pertaining to the Use of Concept Mapping Techniques and Technologies for Education and Performance Support. *Educ Train*. 2003; 3:1–108.
10. Surapaneni KM, Tekian A. Concept mapping enhances learning of biochemistry. *Med Educ Online*. 2013;18:1–4.
11. Kwas H, Ghédira H. Use of the concept mapping in teaching during a medical rotation of interns: an exploratory study. *Tunis Med*. 2017;95(12):229–33.
12. Qadir F, Zehra T, Khan I. Use of concept mapping as a facilitative tool to promote learning in pharmacology. *J Coll Physicians Surg Pakistan*. 2011;21(8):476–81.
13. Baig M, Tariq S, Rehman R, Ali S, Gazzaz ZJ. Concept mapping improves academic performance in problem solving questions in biochemistry subject. *Pakistan J Med Sci*. 2016;32(4):801–5.
14. Hsu LL, Pan HC, Hsieh SI. Randomized comparison between objective-based lectures and outcome-based concept mapping for teaching neurological care to nursing students. *Nurse Educ Today*. 2016;37:83–90.
15. Gonzalez HL, Palencia AP, Umana LA, Galindo L, Villafrade MLA. Mediated learning experience and concept maps: a pedagogical tool for achieving meaningful learning in medical physiology students. *AJP Adv Physiol Educ*. 2008;32(4):312–6.