DO CONCEPT MAPS ENHANCE DEEP LEARNING IN MEDICAL STUDENTS STUDYING PUBERTY DISORDERS?

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ABSTRACT

Objective: To study if concept mapping (CM) is a useful learning approach to enhance meaningful learning in final year medical students compared to traditional methods in an undergraduate medical college to improve learning of puberty disorders in Gynaecology.
Study Design: Quasi experimental study.
Place and Duration of Study: Army Medical College Rawalpindi, from Dec 2016 to Mar 2017.
Methodology: The final year MBBS class was randomized into 2 groups of 100 each that were taught disorders of puberty using interactive lectures of 50 students. One was taught "disorders of puberty" by traditional lecture and the second by CM. There was Delphi agreement of the content of lecture and method of interaction by the faculty of Gynaecology. Multiple Choice Questions (MCQs), Extended matching Questions (EMQs) and Short Answer Questions (SAQs) were used to assess deep learning two days after lecture. Scores were compared individually and overall between the two groups to assess student's learning in the two groups.
Results: Mean score of students in the intervention group was significantly higher than the control group (71.9% vs. 55% of total score, $p<0.001$). The difference of individual scores was more marked in MCQs, EMQs that dealt with pathophysiology and investigations and in SEQs that dealt more with treatment aspect of puberty disorders.
Conclusion: CM method was more successful in learning as compared to lecture-based method. Students in CM group received statistically significant higher scores compared to control group. As a supplement to traditional teaching techniques concept maps promoted meaningful learning.

Keywords: Concept maps, Critical thinking, Deep learning, Meaningful learning.

INTRODUCTION

Concept maps as a resource for learning, allow students to demonstrate their mastery of the concepts related to a particular body of knowledge. Concept mapping (CM) is an innovative activity that cultivates reflection on one's own conception[1]. According to Chula rut and DeBacker[1], concept maps can expedite students' understanding of the organization and integration of important concepts. Torre et al note that students reported: '...the concept maps allowed for creativity by developing a system of thinking that included pattern recognition, the ability to think broadly on topics, and finally, allowed for knowledge integration'[2]. Recent research has examined if and how students with specific learning styles benefit from the use of concept maps. There is evidence that CM function well across groups of learners with multiple and assorted learning styles[3,4]. The essence of these ideas lies in line with the constructivist theory of learning that is at the heart of CM. According to this theory meaningful learning ensues when students incorporate new knowledge into a preexistent conceptual framework[5]. Meaningful learning, the ability to understand and relate relevant medical concepts by linking them to prior knowledge, is of huge developmental value to medical students[6]. It is a fact that concept maps can enable students to implement an organ-based approach that fosters integration of basic science and clinical disciplines[7]. Knowledge management, which is a very important concern in societies with rapidly

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expanding knowledge resources is effectively organized by CM[8].

It also holds promise as an evaluation tool in medical education because it has the potential to measure the advancing knowledge frameworks of students and residents as they move from novice to expert doctors in a way that orthodox examinations cannot[9,10]. Another useful feature of CM in medical education courses is the possibility of incorporating various concepts – which maybe split in many intellectual compartments. It is an exceptional tool to uncover distortions of students' understanding of content[11]. For example, in a variety of secondary school and undergraduate settings, CM has consistently been found to measure conceptual change in situations in which such change would be expected and to distinguish differences between students with more training in a particular field[12,13]. Literature reveals that CM not only promotes higher-level thinking and reflection, but also mirrored the courses structured approach of using concept mapping and reflection to dissect ethical dilemmas[14]. However, developing valid and reliable methods of scoring studies are limited. For example, the concept maps have been shown to reduce normal training time significantly in Naval students but there is limited and controversial evidence in medical education[7,11]. Therefore, further studies on larger sample size and with more arduous design were obligatory to confirm these findings. The objective of the study was to see if concept mapping is useful learning methodology to enhance meaningful learning in final year medical students compared to traditional methods in an undergraduate medical college.

Critical thinking and deep learning is essential in medical education and we must devise ways and means of enhancing it. Various authors have acknowledged the need for alternative teaching and learning strategies that will enable medical students hold huge amounts of knowledge and integrate critical thinking[8,12]. These skills are of great value in education of future doctors. Some researchers in nursing education found that using concept-mapping method is not better than or even equal to the traditional care planning in improvement of critical thinking[13]. Additionally, there is a paucity of longitudinal studies on the use of concept mapping. So this study was conducted to analyze, if concept maps augment meaningful learning (deep learning) as opposed to traditional teaching methods.

METHODOLOGY

This was quasi experimental study conducted in Army Medical College from Dec 2016 to March 2011 about the use of concept mapping in medical education. There were 200 undergraduate final year medical students who were randomly selected and assigned to two groups, group A (n =100) and group B (n = 100) by lottery method. Group A was taught to use concept maps to learn puberty disorders, while group B was taught by traditional lecture method (in groups of 50 each) between Dec 2016 to Mar 2017. Sampling technique used was non-probability consecutive sampling. All students in final year were included except those who were absent on the day of lecture. Sample size calculator was not used in view of large sample size as the entire class was being sampled. Refusal to participate in the study was taken as part of exclusion criteria. Puberty disorders was taught using multimedia. Theoretical knowledge written as a text and patients' pictures in the presentation were identical. The learning outcomes of the two groups were standardized. There was Delphi agreement of the content of interactive lecture and method of interaction by the faculty of Gynaecology. The concept maps were prepared and validated by the faculty Students were randomly divided into two groups: one was taught by traditional didactic lecture based method and the 2nd by adding on already prepared CM to the presentation. During this study, the same faculty member taught both groups of students, and the students of both groups had the same amount of teaching and learning time. Care was taken so that both groups

had the opportunity to clarify understanding by asking for help.

CM is a schematic device for representing concept names connected by directed arcs encoding propositions in the form of simplified sentences[7,9].

Deep learning or meaningful learning is the ability to understand and relate relevant medical concepts by inculcating critical thinking (which is a skill to solve a range of complex clinical problems)[4].

Interactive lecture is a teaching session that allows a two-way flow of information between teacher and student[13] in a large group teaching where the lecturer has a central position.

Ethical issues identified were that student identification will not be disclosed; the research should not just be guided by personal interest but for enhancing student learning. As differing instructional strategies may put a group to disadvantage so control group were taught construction techniques for concept mapping in general after completion of the study. The results were shared with the audience and participants.

Data Collection tools and procedure: MCQs, EMQs, SAQs.

These were 2 SAQs, 6 MCQs 3 and EMQS. These were constructed after peer review to ensure that it is checking not simple recall but higher order thinking. These were administered 2 days after the interactive lecture, were used to assess student's learning in the two groups. Test results of the two groups were compared.

Data were stored and analyzed using SPSS version 23.0, mean and standard deviation were reported for MCQs, EMQs, SAQs and total scores, mean comparison of these scores was done using independent sample t-test, *p*-value ≤0.05 was considered significant.

RESULTS

Total 111 males and 89 females were selected. Results showed that there was significant increase in all scores for those students who were in concept making group with *p*-value ≤0.05 (table-I).

All three scores were found significantly higher among females as compare to male samples (table-II).

There were almost equal number of males and females were in the CM group (fig-1).

CM group did better across the board with all assessment tools (fig-2). The superiority was also maintained in females in CM group (fig-3) elucidating the fact that female group did not depend on simple recall. This defies the prevalent myth that females are better at memorization and recall as opposed to conceptualizing knowledge. We found that the mean score of students in the intervention groups was significantly higher than the control groups (71.9% vs. 55% of total score, $p<0.001$). The difference of individual scores was more marked in MCQs, EMQs that dealt with pathophysiology and investigations and in SEQs that dealt more with treatment aspect of puberty disorders.

Table-I: Comparison of mean scores with concept mapping.

Parameters	Concept Mapping		*p*-value
	Yes (n=100)	No (n=100)	
	Mean ± SD	Mean ± SD	
MCQ score	8.65 ± 1.89	6.17 ± 1.739	<0.001*
SEQ score	13.61 ± 1.77	11.65 ± 2.12	<0.001*
EMQ score	12.70 ± 2.35	9.68 ± 2.216	<0.001*
Total score	34.97 ± 5.43	27.51 ± 5.46	<0.001*

*$p<0.05$ was considered significant using independent sample t-test

Table-II: Comparison of mean scores with gender.

Parameters	Gender		*p*-value
	Male (n=111)	Female (n=89)	
	Mean ± SD	Mean ± SD	
MCQ score	7.09 ± 2.15	8.08 ± 2.15	<0.001*
SEQ score	12.15 ± 2.26	13.45 ± 1.81	<0.001*
EMQ score	10.74 ± 2.87	12.10 ± 2.36	<0.001*
Total score	29.99 ± 6.86	33.64 ± 5.63	<0.001*

*$p<0.05$ was considered significant using independent sample t-test

DISCUSSION

Teaching basic science courses is inspiring in undergraduate medical education because of the

pervasive use of didactic lectures and incentive for recall of factual information during examinations. There is ample evidence that CM can foster shared deeper knowledge of concepts and their complex interconnections, thereby facilitating a better understanding[14]. A study of CM for biochemistry students in PBL indicated that concept

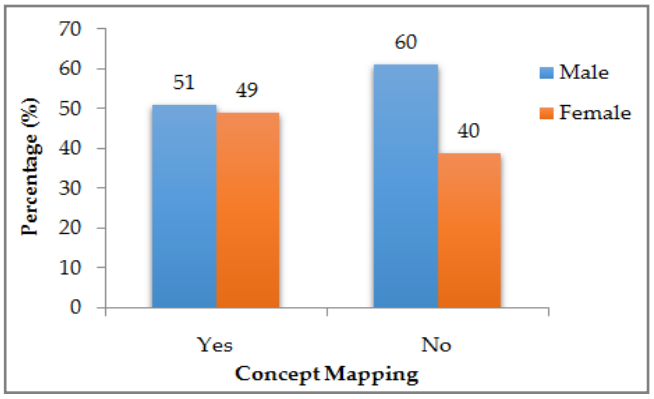

Figure-1: Distribution by gender.

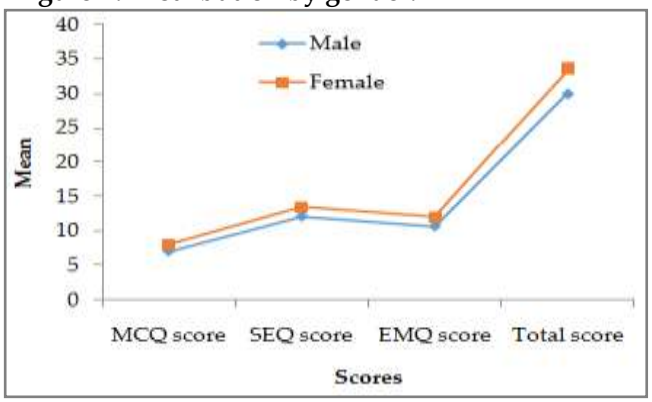

Figure-2: Trend of scores in concept mapping.

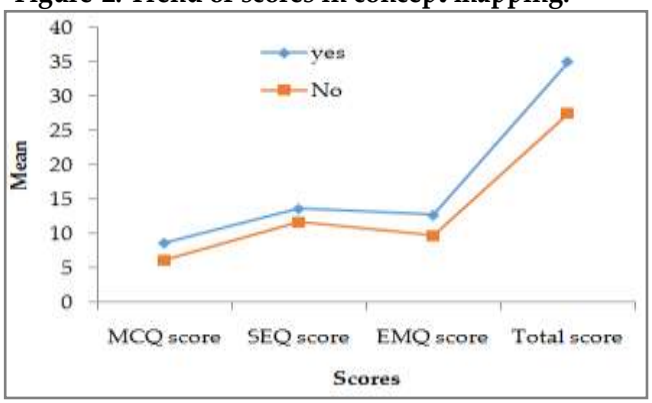

Figure-3: Trend of scores with gender.

mapping encouraged meaningful discussion of the clinical cases in the brainstorming stage; stimulated deep analysis of the medical problem in the organizing stage; facilitated the learning process to organize and integrate information in the layout stage; linked, related the basic biochemical concepts to medical problem in the linking stage; gave an opportunity to assess existing knowledge, gain insights about new and existing knowledge in the revising and finalizing stage, and exchange information by going through all the concept maps made by fellow students during the gallery walk[15,16]. Similar to our study the exercise resulted in higher academic performance compared to the traditional course and was professed favorably by the students[17]. However, we used a group of 50 students in a large group lecture and not in a PBL. In our study we used predesigned CM validated by faculty that were revealed to students in a stepwise interactive manner[18]. These findings strongly confirm that concept mapping is a useful strategy to promote meaningful learning in medical education. In some studies, the post-test scores of concept mapping were not significantly in favor of CM. However, feedback about concept mapping showed that the technique helped the students to conceptualize difficult topics in CNS pharmacology. We did not incorporate student feedback in our study. Overall our students found use of CM to be fun that made the topic palatable and easy to understand as assessed by verbal feedback at the end of interactive lecture.

In some other studies once again students themselves generated the concept maps during a session of PBL[19,20]. This led to effects on higher level learning goals such as problem solving, allocation, application, and analysis; conceptual change and the development of learning skills. We believe that further research into the relationships between concept mapping and clinical reasoning, medical problem solving and diagnostic errors in clinical practice is also needed in medical education[21,22]. If students come prepared and shared their own concept maps then simplicity of learning by CM gives an opening to learn and criticize better many more concepts and evidences. So they will be able to

use and understand faster the best and the most relevant evidences to judge better about their patients. Similar findings were replicated in facilitating a better understanding of epidemiological research[21]. We chose puberty disorders in Gynaecology as it is a very complex topic requiring immense integration of basic and clinical concepts. In our college it is part of core curriculum. It was observed over past decade that students' performance in final year exam was rather sub-optimal in puberty disorders. The fact that students' performance was better regarding investigations and treatment of puberty disorders in the current study speaks of the problem solving ability that CM was able to foster. Concept maps used in our study were given to students for quick revision of concepts before exams.

As Novak and colleagues state: 'While at first glance concept maps may appear to be just another graphic representation of information, understanding the foundations for this tool and its proper use will lead the user to see that meaningful learning, the ability to understand and relate relevant medical concepts by linking them to prior knowledge, is of great formative value"[20].

In some studies, there was more correlation with student's cognitive structure than with exposure to CM. There was a significant interaction effect of learners' prior ability and learning condition on conceptual knowledge but not on near and far transfer performance[20]. Our study was limited by assessment of only near transfer. Our study stratified the results for both genders and superiority of CM group was maintained across the board. Therefore, further studies will be required to test the validity and generalizability of this tool before adopting it in other programs. It would be interesting if we followed our student's performance in the final year exam to see if CM helped in the long term retention of concepts.

One study used worked examples along side concept maps[18]. Worked examples study mingled with concept map completion led to greater allocation of knowledge for both beginner and advanced learners[18]. Our study only targeted final years and not the earlier years. Concept map completion might give learners better insight into what they have and have not yet learned, allowing them to bridge the gap.

In earlier studies criticism about concept mapping showed that the technique helped the students to conceptualize difficult topics in CNS pharmacology[21]. CM was predominantly beneficial in preparing for exams as it provided a quick overview of the entire subject and envisaged individual knowledge improvement. In one study in the past the quality of student concept maps in a PBL curriculum was assessed. Unlike some studies we did not use CM as an assessment tool[23]. However, the concept maps used in our study were given to students for quick revision before final exams.

Concept map have been used in order to teach the approach to a burn patient. Students were provided with web addresses of the concept maps and they were able to check on their own the entire concept map including its links. We did not capitulate such self-regulation.CM would be helpful not only to students but teachers would also benefit[24]. The students in a burn course felt that CM helped them with both pattern recognition and critical thinking and the result of final assessment mirrored the same. We believe that CM will have a wide approval among medical educators as CM gets more disseminated. Our study is in agreement with many studies targeting difficult topics like CNS pharmacology, integration of curriculum, management of burns patients where knowledge management is a problem[18]. Our topic was also complex and enhanced deeper learning by adding on concept maps to such a multifaceted topic. Medical educators can exploit concept maps to identify students' misunderstandings of concepts and to identify knowledge gaps that need to be rectified[24]. Finally, some studies outline the prospective role of concept maps as an assessment tool[24.25].

CONCLUSION

The use of concept-mapping techniques resulted in appreciably superior test scores and fostered a deeper understanding of the basic concepts of puberty disorders to transmit and link to clinical problems.

CONFLICT OF INTEREST

This study has no conflict of interest to be declared by any author.

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