

Effect of Concept Maps on Knowledge Retention in Dental Students

1. Imrana Khan 2. Farida Qadir 3. Aslam Fareed 4. Quratul Ain

1. Prof. of Biochemistry, JM&DC, Karachi 2. Asstt. Prof. of Pharmacology, LNMC, Karachi 3. Head, Research Department, Greenstar Social Marketing Pakistan, Karachi 4. Lecturer of Biochemistry, JM&DC, Karachi

ABSTRACT

Objective: To determine the effect of Concept Maps on Knowledge Retention in Dental students.

Study Design: Randomized study.

Place and Duration of Study: This study was conducted at the Jinnah Medical and Dental College, Karachi.

Materials and Methods: A randomized controlled trial was conducted on fifty students of BDS first year at the Jinnah Medical and Dental College, Karachi. The students were randomly divided into two groups. Initially the whole class was taught the first unit of Biochemistry (Carbohydrates) by the conventional method. It was followed by a Multiple Choice Questions test which established the equivalence in the mean scores of the two groups. The Intervention group now attended a workshop on "Concept Maps". In the next two units (Proteins and Lipids), the Intervention group made Concept Maps while the Control group continued with the conventional method. Each unit ended with an MCQ test. The score of the Unit test was taken as an indicator of short term retention of knowledge. Two months later, an unscheduled Retest was given consisting of all the MCQ given in the three Unit tests. The difference between the scores of the Unit tests and Retest was taken as an indicator of long term retention of knowledge. The mean scores of the two groups were compared using Independent samples t-test.

Result: No significant difference was found in the mean scores of the Intervention and Control groups in the Unit tests. But in the Retest the Intervention group performed significantly better ($p < 0.01$) than the Control group.

Conclusion: Learning through Concept Maps improves long term retention of knowledge.

Key Words: Concept maps, Retention of Knowledge, Medical education

INTRODUCTION

Retention of knowledge is a challenge faced by medical students and their facilitators. Many studies have shown a serious loss of Basic Medical Science knowledge obtained in the early years of medical school.^{1,2,3} This raises concerns about the teaching strategies and learning styles which do not seem to be conducive to the long term retention of that knowledge to be used effectively.¹ Unless the knowledge learnt is organized for easy accessibility, it is not easily retrievable for clinical use. Such dormant knowledge is soon lost.⁴ This compels us to find more effective teaching strategies. Various educational strategies have been employed to improve students retention of medical knowledge e.g. spaced education⁵, problem based learning⁶, interactive learning⁷, high quality of initial learning⁸ etc. Students' learning styles have been analyzed to find a correlation with their academic achievements.⁹ Learning is effective when the learner synthesizes the knowledge and utilizes the concepts to interpret situations and act accordingly.¹⁰

An important tool for organizing and representing knowledge to make it retrievable was put forward by Joseph Novak in the form of "Concept Maps".¹¹ The important concepts are written in individual boxes and arranged in a hierarchical structure with cross linked arrows showing linking words to specify the relationship between two concepts. Knowledge is best understood and retained when it is related to preexisting

knowledge¹², experienced, reviewed, conceptualized and then used for planning subsequent actions¹³. It seems logical that Concept Maps can make instruction "conceptually transparent" to students¹⁴ instead of making it a blur of myriad facts to be memorized.¹⁵ It is beneficial to use Concept maps in small group learning.¹⁶ Concept Maps engender meaningful, organized and retrievable learning instead of rote memorization. The material to be learnt becomes conceptually clear and related to the learner's prior knowledge. More explicit knowledge can then be anchored onto the developing conceptual framework. It has been seen that medical students with a learning style preference of abstract conceptualization performed better on the Multiple Choice United States Medical Licensing Examination.¹⁷ The subject of Biochemistry is heavily dependent on concepts. The objective of this study was to find if learning through Concept Maps increases the retention of knowledge. This would be apparent in their Test and Retest scores. The Test score will show short term knowledge retention and the unscheduled Retest done after a time lapse will show long term knowledge retention.^{18,19} We thus undertook the present study to detect the effect of Concept Maps on the students' Test and Retest scores as an indicator of short term and long term knowledge retention.

MATERIALS AND METHODS

This is a randomized controlled trial conducted to find the effect of Concept Maps on knowledge retention.

The new class of 50 BDS first year students enrolled at the Jinnah Medical and Dental College, Karachi, participated in the trial. It was carried out in the Biochemistry department between January and April 2009. The conventional mode of teaching here is through Lectures followed by Small group discussions. To construct the Intervention and Control groups the students were randomly assigned to two groups. In the pre intervention stage, the whole class was taught the first unit of the syllabus "Carbohydrates" through the conventional system. At the end of the unit a Multiple Choice Questions test was given. An Independent samples t-Test showed no significant difference in the mean scores of the two groups. This showed the equivalence of both groups.

In the post intervention stage, the next two units of the syllabus, "Proteins" and "Lipids" were taught by lectures to the whole class. Each unit consisted of 6 hours of core lectures followed by 6 hours of small group discussions but while the Control group carried on with this conventional method, the Intervention group was given a workshop on Concept Maps and was facilitated to make their own Concept Maps. At the end of each unit there was a test consisting of 10 MCQs. The Unit test scores were used as an indicator of short term retention of knowledge. The scores of the two groups were compared using independent samples t-test to detect change due to the intervention.

Two months after the completion of these three units, an unscheduled Retest consisting of all the 30 MCQs given in the three Unit tests was given to the students as

a surprise test. The score of the individual Unit tests were added to give the Test score. The difference in the scores obtained in the Retest compared to the score of the Unit tests was used as an indicator of long term knowledge retention^{18,19}.

Multiple choice questions were used because of their objectivity, unbiased scoring and ease of correction on computerized answer sheets. The difference in the score for the Unit Test and the Retest for the Intervention group was compared with the Control group. Independent samples t-test was used to compare the performance in the Unit test and Retest for both groups. All the data was analyzed using SPSS version 18.

RESULTS

Table 1 shows the Mean Score (SD) in the Unit Tests obtained by the Control and Intervention groups in the Pre intervention stage (Carbohydrate Unit) and the Post intervention stage (Protein and Lipid Units). The assessment shows that there was no significant difference in the scores obtained by the Control and Intervention groups in the Pre intervention stage. This shows that randomization was correct as the scores of both groups were equivalent ($p > 0.05$). In the Post intervention stage also no significant difference was found in the Unit Test scores of both groups.

Table 2 shows the Mean Score (SD) in the Retest obtained by the Control and Intervention groups for the Units taught in the Pre intervention and Post intervention stages.

Table No.1: Unit Test Score Mean Score (Max. Score = 5) and Standard Deviation

Stage	Unit	Control	Group	Intervention	Group	P Value
		Score	N	Score	N	
Pre Intervention	Carbohydrates	3.16 (1.25)	25	3.32 (1.39)	22	0.683
Post Intervention	Proteins	3.33 (1.24)	18	3.60 (1.28)	20	0.502
Post Intervention	Lipids	1.43 (1.19)	23	1.73 (1.28)	22	0.426

No significant difference in scores

Table No.2: Retest Score Mean Score (Max. Score = 5) and Standard Deviation

Stage	Unit	Control	Group	Intervention	Group	P Value
		Score	N	Score	N	
Pre Intervention	Carbohydrates	3.60(1.32)	25	3.45(1.14)	22	0.471
Post Intervention	Proteins	3.47(1.13)	18	4.75(0.44)	20	0.012*
Post Intervention	Lipids	1.58(1.21)	23	3.27(1.55)	22	0.024*

* $p < 0.05$ i.e. significant difference

Table No.3: Improvement in Scores - Difference in Group Mean Scores (Max. Score = 5) and Standard Deviations in Unit Tests and Retests

Stage	Unit	Group	Unit Test	Retest	Difference	P Value
Pre Intervention	Carbohydrate	Control	3.16(1.25)	3.60(1.32)	0.44(1.23)	0.072
		Intervention	3.32(1.39)	3.45(1.14)	0.13(1.61)	0.698
Post Intervention	Protein	Control	3.33(1.24)	3.47(1.13)	0.14(1.03)	0.414
		Intervention	3.60(1.19)	4.75(0.44)	1.15(1.34)	0.001**
Post Intervention	Lipid	Control	1.43(1.19)	1.58(1.21)	0.15(1.43)	0.538
		Intervention	1.73(1.28)	2.86(1.49)	1.13(1.52)	0.001**

** $p < 0.01$ significant improvement

Table No.4: Comparison of Improvement in Scores Between the Control and Intervention Groups Difference in Group Mean Scores (Max. Score = 5) and Standard Deviations in Unit Tests and Retests

Stage	Unit	Control Group	Intervention Group	P Value
Pre Intervention	Carbohydrates	0.44(1.23)	0.13(1.61)	0.462
Post Intervention	Protein	0.14(1.03)	1.15(1.34)	0.006**
Post Intervention	Lipid	0.15(1.43)	1.13(1.52)	0.026*

**p<0.01 significant difference * p<0.05 significant difference

The result showed no significant difference in the scores obtained by both groups for the Unit taught in the Pre intervention stage. However for the Units taught in the Post intervention stage, there was a significant difference ($p<0.05$) between the scores obtained by the Intervention group compared to the Control group.

Table 3 shows the difference between the mean MCQ score in the Unit tests compared to the Retest for the two groups in all the three units. In the Pre intervention unit "Carbohydrates", no significant difference was found in the scores of the two tests for either group. But in the Post intervention units i.e. "Protein" and "Lipid", significant difference ($p<0.01$) was found between the scores of the Unit tests and Retest for the Intervention group. The Control group showed no significant difference in the scores of the two tests.

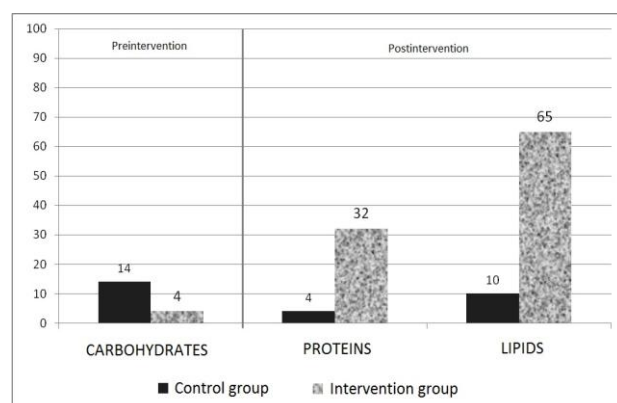
**Figure No.1: Percent improvement in mean scores**

Table 4 compares the performance of the Intervention and Control groups in the improvement of scores obtained in the Retest related to the Unit tests. It shows no significant difference between the two groups for the unit taught in the Pre intervention stage. But in the Post intervention stage there is a significantly marked improvement ($p<0.05$) in the scores of the Intervention group compared to the Control group for both the units i.e. "Protein" and "Lipid".

Figure I shows the percent improvement in the mean MCQ scores of the Control and Intervention groups obtained in the Unit Test and Retest for the three units "Carbohydrate", "Protein" and "Lipid". It shows that in the pre intervention stage for the unit "Carbohydrate" there was no significant difference in the Test and Retest scores obtained by the two groups. But in the post intervention period for the unit "Protein" there is an improvement of 32% in the score for the Intervention group but only 4% for the Control group.

Similarly for "Lipid" there is an improvement of 65% in the score for the Intervention group but only 10% for the Control group. There is thus significant improvement ($p<0.01$) in the score of the Intervention group compared to the Control group.

DISCUSSION

With the explosion of knowledge there is a need for innovative educational strategies to boost the retention of knowledge. This study highlighted two aspects of knowledge retention, short term and long term benefits of making Concept Maps while studying. It was expected that using Concept maps would improve knowledge retention in the short term and long term. This expectation was based on the assumption that Concept maps stimulate the construction of integrated knowledge structure leading to higher achievement in test scores. But contrary to our expectations, the result of the current study showed that learning through Concept Maps did not significantly alter the test scores in the short term test at the end of each Unit. This is consistent with other studies which show that a small scale exposure to an innovative educational strategy does not alter the students' scores¹⁸. Similarly in a Continuing Medical Education program no improvement of scores was observed when attendees were taught by an Interactive teaching format¹⁹. In another study conducted on high school students, no significant difference in mean scores was found between the Experimental group and the Control group after teaching the former with Concept Maps²⁰. A study conducted on tenth grade students to explore the relationship between performance on Concept Maps and Chemistry test achievement showed no significant difference in the scores obtained by the Experimental group compared to the Control group²¹. In one of our previous studies we have reported similar results when students were taught Pharmacology by using Concept Maps²². This implies that the result of a short term innovative teaching strategy is not apparent immediately. One reason could be that the construction of Concept Maps is difficult to master initially^{20,23}. It may also be possible that in conventional scheduled tests, short term memorization may lead to better or equivalent scores. Hence no immediate benefit in short term retention of knowledge was observed when the students were taught to use Concept Maps.

However the results obtained in the Retest are very interesting. They uniformly show a higher score for the

Retest compared to the Unit Test. This is because the same questions were repeated in the Retest which had been used in the three Unit Tests thus leading to an improvement in the score. The same questions were used so as to remove any bias regarding the difficulty level of the questions. Thus the Retest tested purely the Retention of knowledge. There is no threat to internal validity because the Control and Intervention groups were both exposed to the same questions yet there was consistently better performance observed in the Intervention group. This exercise resembled Spaced Education which is a proven method of improvement in learning with long term benefits²⁴. This finding is also consistent with a similar study done in Pharmacology where the score was higher in the Retest than in the Unit test, 8 months after the initial test²⁵. In another study it was found that a positive effect was achieved by using Concept Maps as an instructional tool when the study ranged from two to twenty two weeks duration with an average of six weeks²⁶.

When compared with the Control group, the Intervention group performed significantly better ($p < 0.01$) in the Retest in both the post intervention units, "Proteins" and "Lipids". This clearly showed that learning through Concept Maps leads to long term retention of knowledge. This may be because the visual presentation of knowledge results in better learning, recall and retrieval of information than the auditory presentation alone.²⁷ Concept Maps convert knowledge into a visual image which could be recalled better.

The main limitations of this study were the small sample size of 50 BDS students and also the short term of the intervention. Increasing the sample size and the study duration may have revealed more beneficial effects of using Concept Maps.

CONCLUSION

Concept Maps improved the long term Retention of Knowledge among students which suggests that it may be used as an efficient teaching tool.

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Address for Corresponding Author:**Dr Imrana Khan,**

Prof. of Biochemistry,

Jinnah Medical and Dental College,

22-23, Shaheed e Millat Road, Karachi

Phone: (Off) 021-34931886-9,

Cell: 0300-8273955

E mail: drimranakhan@gmail.com