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Learning with Concept Maps versus Classical Lecture and Demonstration Methods in regards to Gross Anatomy of Knee Joint: A Comparison

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Abstract

Introduction: Higher education like medical education aims not only to prepare students to learn existing knowledge but to generate new knowledge and apply that knowledge to solve complex problems.Research suggests that complex problems can be solved with the help of knowledge integration. The use of conceptmaps as teaching toolfacilitates knowledge integration.Present study was undertaken to sensitize students to use concept maps and to compare learning with concept maps versus with traditional lecture and demonstration methods. *Methods:* A randomized cross sectional prospective study was conducted on 120 medical students of 1st year. Students were divided into 3 groups A, B and C. Group A studied "Gross anatomy of knee joint" by developing concept maps in number of small subgroups. Group C learnt through lecture and demonstration methods. Group B studied with concept maps developed individually by each student. Pre and posttest were conducted for all groups with pre validated questionnaire. Feedback was obtained from both students and faculty through a 5 point Likert scale. Students T test was applied for statistical analysis. *Result:* There was significant improvement in knowledge in group A and B students in comparison to group C students. This improvement was more marked in regards to high cognitive type MCQs. 90% students found that development of concept maps helped them to understand topic better. *Discussion and Conclusion:* Concept mapping is a better teaching learning tool than lecture and demonstration methods. Teaching-learning with development of concept maps individually or collaboratively facilitates higher cognitive learning.

Keywords: Concept Maps; Knee Joint; Knowledge Integration; Meaningful Learning.

Introduction

Lecture is the most common method of teaching-learning in medical education [1]. However, the retention of knowledge and recall from lecture is less than 5% after 6 months [2]. Higher education like medical education aims not only to prepare students to learn existing knowledge, but to generate new knowledge and apply that knowledge to solve complex problems. To make sense of any complex problem requires connecting ideas and eliciting relations between ideas. This sense making refers to the placement of items into frameworks, comprehending, redressing, constructing meaning and patterning [3]. Continuous effort to understand connections of items present in framework [4] allows to solve the complex problem. Research suggests that in order to form an integrated knowledge, learners need to add and distinguish new ideas and connections to their existing repertoire of ideas rather than replace existing ideas [5,6,7].

Knowledge integration describes learning as the process of integrating ideas through the cognitive processes. Knowledge integration [8,9] involves eliciting preexisting concepts, adding new concept,

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connecting new concept with preexisting concept, critiquing, distinguishing concepts, sorting and refining new concepts and lastly applying these concepts in cognitive process.

To facilitate knowledge integration processes, concept maps can serve as tools to elicit relations between ideas within and across contexts. Concept maps can be defined as a form of node-link diagram for organizing and representing semantic relations among ideas [10].

Like other node-link diagrams, concept maps consist of visuo-spatially arranged nodes and links, but additionally they also present semantic information in the form of link labels. A concept map consists of nodes (ideas/concepts), directional linking lines, and linking labels that describe the relation between nodes. Two nodes connected with a labeled line are called a proposition [11].

Bransford, Brown, and Crocking [8] concluded that concept maps can change students' understanding beyond remembering isolated ideas to constructing meaningful connections of organized knowledge. Mason [12] observed that once students are exposed to concept 'mapping' during instructions, they demonstrated insight into the inter-relationship of different concepts instead of just seeing scientific knowledge as a collection of isolated facts.

Ali Saeedi et al [13] compared different methods of presentation and concept map formation. Authors concluded that the best way for use of concept maps is teacher-generated concept maps with texts.When concept maps are generated collaboratively in groups, they become shared social artifacts that elicit existing and missing connections and spur discussion among students and teachers. Both concept maps and collaborative learning have been found to have educational benefits [11].

Present study was undertaken to compare learning with traditional lecture and demonstration methods versus learning with concept maps developed individually and collaboratively. Faculty and students feedback was also collected in regards to utility of concept maps in learning process.

Materials and Methods

A randomized cross sectional prospective study was conducted after taking due permission from IEC and obtaining consent from students. 120 students of 1st year MBBS class of Gujarat Adani Institute of Medical Sciences, participated in the study. Students were randomly distributed in three groups A, B and C. Each group consisted of 40 students. The topic of study was gross anatomy of knee joint.

Group A was exposed to concept mapping and study of specimens of knee joint in dissection laboratory. This group had two sessions of concept mapping. 1st session of one hour on day one was conducted to make them aware about the process of development of concept maps with the help of an example. In 2nd session of three hours, the next day, students were divided into 8 small subgroups of 5 students each. Each group developed its own the concept maps of gross anatomy of knee joint (Figure 1). Students worked in collaboration in each group. Faculty facilitated the process by answering any queries of students without actually aiding the students to form concept map. This was followed by two sessions of dissection laboratory, of two hours each, for them to study the knee joint according to their concept mapping.

Group B was also exposed to concept mapping and study of specimens of knee joint in dissection laboratory same as group A. The only difference was that the students of group B developed concept maps individually.

Group C was exposed to traditional lectures and demonstrations of specimens of knee joint in dissection laboratory. They had three sessions of lectures of one hour each. Each lecture was followed by a session of demonstration of specimens, on 3 consecutive days. They were given 2 hours of dissection laboratory hours for self-study. Three topics, Gross anatomy of knee joint, internal structure and movements of knee joint and applied anatomy of knee joint were covered in the lectures.

Pretest and post-test were given to all students. Pre and post-tests consisted of pre validated 10 single correct answer type MCQs, to test recall and 5 single correct answer case history type MCQs, to test higher cognitive learning. Total marks for both types of MCQs were equal. A questionnaire was given to each group to get the feedback from students. It was in the form of Likert's five point scale, 1. Strongly disagree, 2. Disagree, 3. Neutral, 4. Agree and 5. As Strongly agree. Similar questionnaire was given to faculty to get their feedback.

Statistical analysis was done on the data obtained with the help of Microsoft excel software to find out the median, mode and standard deviation; student t test was applied to find out any significant difference in the marks. Significant p value was taken as <0.05.

Results

Table 1 : Mean marks obtained by students of group A, B and C in pretest and post-test and standard deviation. Comparison of p value of pre and post-test

	Pre test- Maximum Marks=20		Comparison of p value- Pre test	
Group	**Mean marks**	**Standard deviation**	**Group**	**P value**
A	6.42	2.53	A and C	0.6526
B	6.52	2.57	B and C	0.8613
C	6.175	2.41	A and B	0.5323
	Post test - Maximum Marks=20		Comparison of p value- Post test	
A	14.6	2.79	A and C	P < 0.0001
B	12.4	2.42	B and C	P = 0.0003
C	9.8	3.51	A and B	P = 0.0002

Table 2 : Mean marks obtained by students of group A, B and C in questions of pre and post-test meant to test higher cognitive knowledge. Standard deviation is also included in table. Comparisons of p value of the same are given in table

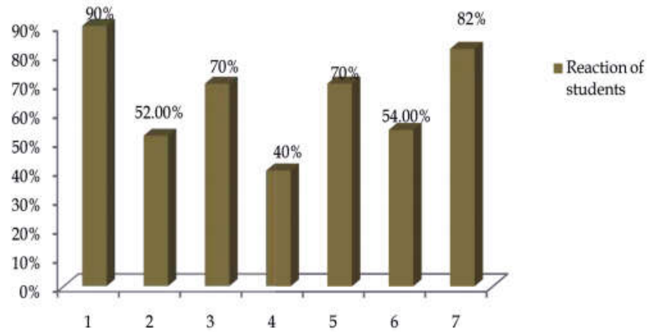
	Pre test- to test higher cognitive knowledge- Maximum Marks=10		Comparison of p value- Pre test	
Group	**Mean marks**	**Standard deviation**	**Group**	**P value**
A	3.55	2.09	A and C	0.8268
B	3.05	2.17	B and C	0.2984
C	3.45	1.97	A and B	0.3912
	Post test - to test higher cognitive knowledge- Maximum Marks=10		Comparison of p value- Post test	
A	8.3	1.91	A and C	P < 0.0001
B	6.45	2.02	B and C	P = 0.0001
C	4.65	2.32	A and B	P = 0.0004

Table 3: Mean marks obtained by students of group A, B and C in questions of pre and posttest meant to test recall knowledge. Standard deviation is also included in table. Comparisons of p value of the same are given in table

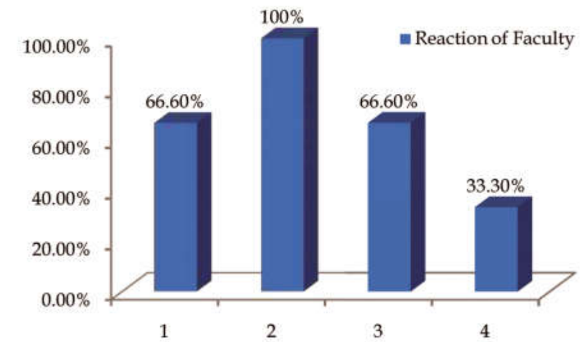
	Pre test- to test recall knowledge- Maximum Marks=10		Comparison of p value- Pre test	
Group	**Mean marks**	**Standard deviation**	**Group**	**P value**
A	2.87	1.38	A and C	0.6465
B	3.47	1.79	B and C	0.0474
C	2.72	1.53	A and B	0.0972
	Post test - to test recall knowledge- Maximum Marks=10		Comparison of p value- Post test	
A	6.3	1.84	A and C	0.0118
B	5.95	1.62	B and C	0.0631
C	5.15	2.14	A and B	0.3693

Table 4: Comparison of obtained mean marks in pre and posttest in the same group

Group	**Comparison of obtained mean marks in pre and posttest to test higher cognitive knowledge (p value)**	**Comparison of obtained mean marks in pre and post to test recall knowledge (p value)**
A	< 0.0001	< 0.0001
B	< 0.0001	< 0.0001
C	= 0.0148	< 0.0001



Graph 1: Percentage of students who responded with >3 score on Likert Scale in response to question 1 to 7 (Table 5)



Graph 2: Percentage of Faculty who responded with >3 score on Likert Scale in response to question 1 to 4 (Table 6)

Table 5: Student's reaction obtained on Likert's scale

S. No.	Reaction of Students to following statements on Likert's scale
1	Creating a concept map of gross anatomy of knee joint has helped me to understand the topic better.
2	Lecture and demonstration have helped me to understand the topic better.
3	I developed deeper understanding of the topic with development of each step of the concept map.
4	I developed deeper understanding of topic with lecture and demonstration.
5	I enjoyed the whole process of creating a concept map.
6	Development of concept map takes more time than usual traditional learning.
7	The development of concept map should be included in curriculum.

Table 6: Faculty's reaction obtained on Likert's scale

S. No.	Reaction of Faculty to following statements on Likert's scale
1	Developing concept maps is a better method of teaching learning than lecture and demonstration
2	I enjoyed the whole process of creating a concept map with students.
3	Development of concept map takes more time than usual traditional learning.
4	The development of concept map should be included in curriculum.

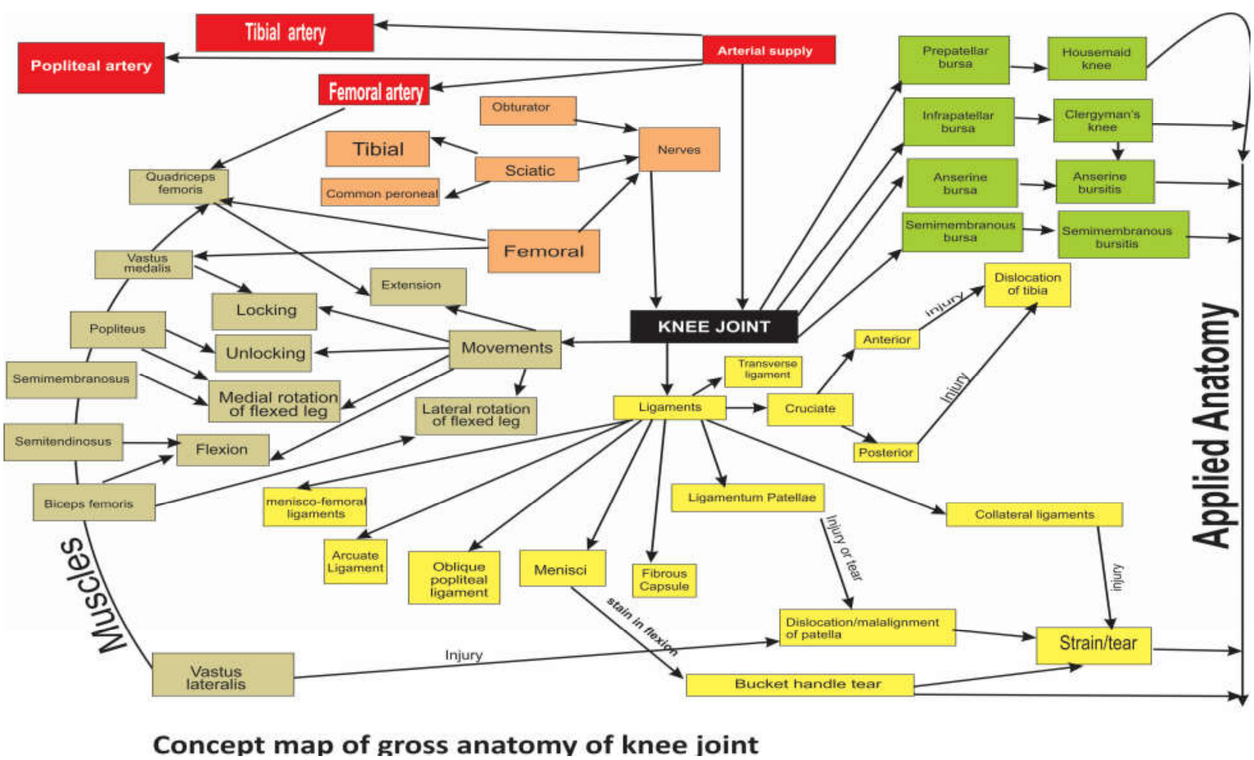


Fig. 1:

Discussion

The 'gestalt effect' of concept maps allows viewing many ideas at once, increasing the probability of identifying gaps and making new connections. Generating concept maps requires learners to represent ideas in a new form which can pose desirable difficulties [14] - a condition that introduces difficulties for the learner to slow down the rate of learning and enhance the long term learning outcomes, retention and transfer. The process of translating ideas from texts and images to a node-link format may foster deeper reflection about ideas and their connections [15] and prevent rote memorization [16].

Textbooks have fixed sequence or order of presentation. Concept maps have no such fixed sequence or order and may thereby encourage knowledge integration. Adding and revising concept maps require students to decide which ideas and connections to include or modify. Developing such criteria to select ideas require deeper processing of knowledge than the student might normally exercise when reading text. The decision-making process may foster the generation of criteria to distinguish pivotal ideas. Clustering the related ideas in spatial proximity can support learners' reflections on shared properties of and relationships between ideas. Links between ideas from different areas can be seen as indication for knowledge integration across different contexts. Students need to develop meta-cognitive strategies to distinguish alternative ideas [8].

Research suggests that concept mapping is especially efficient, in comparison to other interventions such as outlining or defining ideas, for learning about the relations between ideas [11]. Concept maps as knowledge integration tools elicit ideas as nodes (concepts) and relations between ideas as labeled arrows. The visual format of concept maps can foster criticaldistinctions between alternative ideas and relationships, either individually or through collaboration in communities of learners.

Present study was intended to compare learning with concept maps developed individually and collaboratively in groups versus learning with classical lecture-demonstration methods. Statistically significant difference was found between learning with concept maps, group A and learning with lecture-demonstration methods, group C. The p value was <0.0001 (Table1). Mean marks obtained in post-test by group A were 14.6. Mean marks obtained by group C were 9.8 (Table 1). Hence, results show higher academic performance with use of concept maps as learning tool developed collaboratively than traditional lecture and demonstration methods in gross anatomy of knee joint. Previous studies, by Yavuz Erdoðan [17] on Turkish medical students and by Horton et al [18] in 19 classroom implemented quantitative studies, observed higher academic success with concept mapping in comparison to traditional lecture demonstration methods. Farzane Saeidifard et al [19] carried out a randomized controlled trial on seventy six medical students during sixth year of 7-year MD curriculum clerkship phase. Authors concluded that the concept mapping method may develop meaningful learning among medical students. Sylvia C Vink et al [20] (2015) conducted a study on seven groups of expert clinicians and basic scientists and seven groups of residents with a similar disciplinary composition who constructed concept maps about a clinical problem that fit their specializations. Residents outshone experts as regards learning to articulate integration as comparison of the draft and final versions showed. Constructing concept maps in multidisciplinary groups of three has been found helpful. However, Farida Qadir et al [21] conducted a study on 50 dental students and found no significant difference in marks obtained by the group studied with concept maps versus the group studied with traditional learning methods. Thus, most of the studies have similar results as the present study.

There was a statistically significant difference (p value 0.0002) found between group A and group B (Table 1). Mean marks obtained in post-test by group A were 14.6 and group B were 12.4 (Table 1). This indicates that learning with collaboratively developed concept maps leads to higher knowledge retention in comparison to the learning with concept maps developed individually in gross anatomy. Cañas [11] observed that when concept maps are generated collaboratively in groups, they become shared social artifacts that elicit existing and missing connections and spur discussion among students and teachers. Both concept maps and collaborative learning have been found to have educational benefits [11]. Present study also suggests that learning with collaboratively developed concept maps give better result than learning with concept maps developed individually.

There was statistically significant difference (p value 0.0003) found between group B and group C (Table 4). This signifies that there is positive difference in knowledge retention when learning with individually developed concept maps in comparison to learning with traditional lecture and demonstration methods in gross anatomy. Nesbit and

Adesope [22] conducted a meta-analysis of fifty-five experimental and quasi-experimental studies in which students learned how to use concept maps. They found that the use of concept maps was associated with increased knowledge retention, with mean effect sizes varying from small to large depending on how the concept maps were used. However, Ali Saeedi et al [13] compared different methods of presentation and concept map formation. Total 66 students of 3rd year high school participated in the study. The results of this study indicated that presentation of pre-prepared concept maps significantly improved comprehension, compared to the map generation and control group. Authors concluded that the best way for use of concept maps is teacher-generated concept maps with texts.

Integration of knowledge leads to meaningful learning. Meaningful learning is the part of higher cognitive learning process. In the present study, case history type MCQs were given to test higher cognitive learning. The results indicate statistically significant difference (p value <0.0001) between learning with concept maps developed collaboratively, Group A and learning with lecture-demonstration methods, Group C (Table 2). Mean marks obtained in group A were 8.3 (Table 2) while mean marks obtained by group C were 4.65(Table 2). The above results emphasize that use of concept maps as teaching learning tool developed in a group facilitates higher cognitive learning in comparison to lecture and demonstration methods. This is similar to the findings of Clayton LH [23] and Daley et al [24]. Clayton LH [23] (2006) concluded on review of the current state of the science with regard to concept mapping demonstrated that this teaching-learning method assists nurse educators to prepare graduates to think critically in the complex health care environment.

There was statistically significant difference (p value 0.0004) found between mean marks obtained by group A and group B (Table 2). Mean marks obtained by group B were 6.45 (Table 2). This signifies that learning with concept maps developed collaboratively facilitates higher cognitive learning than learning with concept maps developed individually in gross anatomy.

There was statistically significant difference (p value 0.0001) between mean marks obtained by group B and group C (Table 2). This indicates that there is better higher cognitive learning when learning with concept maps developed individually than learning with lecture and demonstration methods. Other studies e.g. Sarhangi F et al [25] compared the effect of lecture and concept mapping based learning, on cognitive learning in their study on 66 fifth semester nursing students in cardiovascular course. They concluded that concept mapping method is more effective in reaching meaningful learning and high levels of understanding than lecturing method. In other comparative study conducted by Hilda Leonor Gonza´lez et al [26] on 3rd semester medical students on mediated learning experience and concept maps versus traditional teaching learning, they observed that intervention with concept maps promoted meaningful learning that allowed the students to transfer this knowledge to solve problems.

Knowledge retention for simple recall was observed similar in group A in comparison to group B (p value <0.3693) and C (p value 0.0118) (Table 3). Same is true for comparison of Group B and Group C (p value 0.0631) Hence, use traditional lecture and demonstration methods is as good as use of development of concept maps as learning tool for recall knowledge.

A statistically significant difference was found between mean marks obtained in pretest and post-test of group A. The p value for the mean marks obtained to test simple recall was calculated as <0.0001(Table 4). The p value for the mean marks obtained to test higher cognitive knowledge was calculated as <0.0001(Table 4). Therefore, use of concept maps as learning tool facilitates recall and higher cognitive learning both.

In group C, the p values for marks obtained in MCQs to test recall and MCQs to test higher cognitive learning were calculated as <0.0001 and 0.01 respectively in pre and post-tests (Table 4). Hence, one can conclude that traditional lecture and demonstration methods facilitate simple recall knowledge and learning better than higher cognitive learning.

In group B, the p values for marks obtained in MCQs to test recall and MCQs to test higher cognitive learning were calculated as <0.0001 and <0.0001 respectively in pre and post-tests (Table 4). It shows that learning with concept maps facilitate simple recall knowledge as well as higher cognitive learning.

No statistically significant difference was found in mean marks obtained by Group A, B and C in pretest questions to test recall and pretest questions to test higher cognitive learning (Table 1, 2 and 3). This suggests that the initial knowledge base of all students included in study was equal for the given topic.

In a study by Anto´nio B. Rendas et al [27], all 14 students claimed that concept maps provided a useful visualization of the concepts, were a good tool to study and revise the content of each block, promoted meaningful learning instead of rote learning and could be progressively produced. In the present study, questionnaire was focused to get students reaction on the understanding of the subject topic, time taken to develop concept maps and their opinion to include it in regular teaching learning process (Table 5). Majority (90%) agreed that creating concept maps helped them to understand the topic better and 70% thought that they developed deeper understanding of the topic with development of each step. Most (70%) enjoyed developing concept maps (Graph 1). More than half students (54%) however felt that it is time consuming (Graph 1). 52% found that lecture and demonstrations also developed deeper understanding (Graph 1). Majority students (82%) agreed that concept mapping should be included in curriculum (Graph 1).

D. M. Torre et al [28] described students' reaction in his study that concept maps fostered a positive connection between theory and practice. Students further described concept mapping as a teaching methodology, as a facilitator of knowledge integration and critical thinking, and finally, as a method which helped them in learning process. Ritchhart et al [29] found that concept maps as a metacognitive tool, can support student's self-reflection about their conceptions of thinking and thinking processes. In another study, students found that concept maps enhanced their capacity to develop clear concepts in pharmacology and in getting a comprehensive and accurate overview of the entire topic. This helped in quick revision before exams [21](Farida et al).

Students' reaction in present study also confirms views expressed in previous studies that concept mapping helps in developing deeper understanding, meaningful learning and critical thinking. Concept mapping is one of the tools of self-directed learning. Present system of medical education in India does not facilitate self-directed learning; this could be one of the reasons why students felt that concept mapping is time consuming.

Majority faculty members felt that concept mapping is a better teaching learning tool than lecture and demonstrations but it is time consuming (Graph 2). The questionnaire was focused on utility of concept maps and their feasibility (Table 6).

Conclusion

Concept mapping is a better teaching learning tool than lecture and demonstration methods. Teaching-learning with development of concept maps individually or collaboratively facilitates higher cognitive learning. Learning with development of concept maps in a group leads higher academic performance than learning with concept maps developed individually. Concept maps as a teaching-learning tool should be included in medical undergraduate curriculum to facilitate knowledge integration, meaningful learning and critical thinking.

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