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EFFECTS OF TEACHING CHEMISTRY USING CONCEPT MAPS ON STUDENTS' ACHIEVEMENT IN SCHOOL CHEMISTRY IN INDIA AND TURKEY

HINDISTANDA VE TURKIYEDEKI OKULLARDA, KAVRAM HARITALARI KULLANIMININ KIMYA EGITIMINDE, OGRENCILERIN BASARILARI UZERINDEKI ETKILERI

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Abstract

A concept map is a form of two dimensional diagramming that emphasises the relationship between concepts. According to many research conducted on concept mapping indicate that concept mapping is one of the best instructional tool that can be used by teachers to generate a meaningful discussion of students' ideas. The potentials of concept mapping motivated the researcher to study the effectiveness of concept mapping strategy as an instructional tool for teaching chemistry in schools of two different countries. The design of the study was quasi experimental Pre-test and post-test non-equivalent group design. The sample comprised of 200 students of two different central schools of New Delhi and 200 students of two different state schools of Gaziantep. In the light of six objectives, nine hypotheses were formulated. Pre-achievement test and post-achievement test were used for data collection. After the collection of data, mean(x), standard deviation (δ), t tests and f tests were used as inferential statistics. Hypotheses are tested at 0.05 level of significance. The findings of the study determine that; concept mapping model is significantly more effective than conventional method of teaching in chemistry in terms of overall achievement, understanding and problem solving ability in IXth class students in the schools of India. Concept mapping model is significantly more effective than conventional method of teaching in chemistry in terms of overall achievement, knowledge and understanding in IXth class students in the schools of Turkey. It was concluded that concept mapping could be used by teachers as an effective teaching strategy in IX. Class chemistry education.

Key words: concept map, concept mapping strategy, effective teaching strategy, chemistry.

Öz

Kavram haritası kavramlar arasındaki ilişkiyi belirten iki boyutlu diyagram şeklindedir. Kavram haritaları üzerinde yapılan bir çok araştırmaya göre, kavram haritaları öğrencilerin fikirlerini anlamlı bir tartışma oluşturmak için öğretmenler tarafından kullanılabilecek en iyi öğretim araçlarından biri oldugu saptandı . Kavram haritalarının potansiyel gücü, araştırmacıyı iki farklı ülkenin okullarında kavram haritalama stratejisinin etkinligini araştırmaya motive etti. Çalışma, yarı deneysel ön başarı testi ve performans başarı testine dayanan eşdeger olmayan grup dizaynı şeklindedir. Örnek çalısma, hindistanın Yeni Delhi şehrinde iki farklı okulldan 200 ögrenciyle, Türkiyenin Gaziantep şehrinden iki farklı okuldan 200 öğrenciden oluşmuştur. Bu çalişmada altı hedef belirlendi, bu hedeflerin ışıgında dokuz hipotez formüle edildi. Ön başarı testi ve performance başarı testi veri toplama aracı olarak kullanıldı. Verilerin toplanmasının ardından, aritmatik ortalama, standart sapma, t-test ve f-test gibi sonuca ulaştıracak istatistiksel teknikler kullanıldı. Hipotezler 0.05 anlamlılık seviyesi kriter alınarak test edildi. Yapılan bu çalısmadaki bulgulara göre; kimya eğitiminde kavram haritalama modeli, genel başarı, anlama ve problem çözme yetenegi açisindan Hindistandaki okulların IX. sınıf öğrencileri üzerinde geleneksel eğitim metodundan daha etkili oldugu gozlendi. Kimya egitiminde kavram haritalama modeli, genel başarı, bilgi ve anlama açısından türkiyedeki okulların IX. sınıf öğrencileri üzerinde geleneksel eğitim metodundan daha etkili oldugu gozlendi. Sonuç olarak, kavram haritalama, IX. sınıf kimya eğitiminde etkili öğretim stratejisi olarak kullanılabilir.

Ahatar kelimeler: kavram haritası, kavram haritamana stratejisi, etkili öğretim stratejisi, kimya.

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1. INTRODUCTION

Many research works proclaims that the subject of Chemistry is a complex subject in terms of knowledge, comprehension and application that has dominated the field during the past 10-15 years. The reason of this complex structure of chemistry is due to abstract and inexplicable concepts in chemistry. Elements, compound, chemical change and physical change are the concepts which are at microscopic level. These concepts can be taught at macroscopic level by simple proposition for example the difference between elements and compound can be explained as; elements cannot be decomposed by ordinary chemical means, whereas compounds can be. This explanation is enough for teaching chemistry concepts at first step but not enough for complete understanding. These concepts must be related to subsequent concepts for complete learning. Otherwise information either not be stored, or it will be stored as a single entity. Hence, if something does exist to which the new concept can be related, then learning occurs. It is thought that analogies can take on this function, but in order to be effective, the students must understand the analogy and see the link between the concept being taught. These thought patterns existing in long-term memory can be represented by concept maps.

Ausubel is the founder of the concept of meaningful learning. Ausubel examined the difference between meaningful learning and rote learning in 1981. According to Ausubel, rote learning, was the terms encountered for the first time, such as the multiplication table, chemical symbols of the elements, foreign words, the names of the compounds etc. are just taken and stored in mind without any integration or interrelation. All of these items and names are unique and should be kept as they are. Whereas, meaningful learning is the opposite of rote learning where knowledge and concepts which learned is linked to each other.

Concept maps were developed in 1983 in the course of Novak's research program based on Ausubel's meaningful learning principles. According to Novak, concept mapping is so powerful for the facilitation of meaningful learning. Concept map presents visual presentation of ideas, shows alternative relationships within a system and provides clarity of the concept. Concept maps can be used for many purposes in chemistry education; as a method of learning, as a teaching method, as a curriculum and lesson planning method, as a evaluation method of students' performance. In addition, it helps to identify misconceptions held by students.

1.1. The Problem

This present study attempts to observe the effect of use of concept maps in teaching chemistry. The focus questions of the present study are as follows:

- Do concept mapping foster better achievement (concept learning) as compared to the conventional method of teaching chemistry in schools in India?
- Do concept mapping foster better achievement (concept learning) as compared to the conventional method of teaching chemistry in schools in Turkey?
- Do concept mapping foster better achievement (concept learning) in India or in Turkey?

These questions led the investigator to state the problem as;

"Effects of teaching chemistry using concept maps on students' achievement in school chemistry in India and Turkey"

2.1. Objectives

The main objective of the study can be summarised as below:

To study the effectiveness of teaching through concept mapping on students' achievement in school chemistry in India and Turkey. The specific objectives of the study are as follows;

1. To develop concept maps in chemistry on selected topics in chemistry.
2. To study the effectiveness of concept maps as an instructional tool in gaining knowledge about concepts in chemistry among students as compared to the conventional method of instruction.
3. To study the effectiveness of concept maps as an instructional tool in developing understanding among students as compared to the conventional method of teaching.
4. To study the effectiveness of concept maps as an instructional tool in enhancing the problem solving ability among students as compared to the conventional method of teaching.
5. To study the effects of teaching chemistry through concept maps and its impact on students achievement.
6. To compare the achievement in chemistry of Indian and Turkish students in conceptual learning using concept map.

1.3. The Hypothesis

The review of the related literature helps to formulate the following research hypothesis.

Hypothesis 1: There will be no significant difference of the knowledge in chemistry between the students, taught through traditional lecture method of teaching and taught through concept mapping strategy, among the students of secondary classes in the schools in India.

Hypothesis 2 : There will be no significant difference of the knowledge in chemistry between the students, taught through traditional lecture method of teaching and through concept mapping strategy, among the students of secondary classes in the schools in Turkey.

Hypothesis 3: There will be no significant difference in understanding of the students taught through traditional lecture method of teaching and taught through concept mapping strategy, among the students of secondary classes in the schools in India.

Hypothesis 4 : There will be no significant difference in understanding of the students taught through traditional lecture method of teaching and taught through concept mapping strategy, among the students of secondary classes in the schools in Turkey.

Hypothesis 5 : There will be no significant difference in the student's ability to solve problems related to chemistry among the students taught through traditional lecture method of teaching and taught through concept mapping strategy, among the students of secondary classes in the school in India.

Hypothesis 6 : There will be no significant difference in the student's ability to solve problems related to chemistry among the students taught through traditional lecture method of teaching and taught through concept mapping strategy, among the students of secondary classes in the school in Turkey.

Hypothesis 7 : There will be no significant difference in the overall achievement of chemistry between the student, taught through traditional lecture method of teaching and taught through concept mapping strategy, among the students of secondary classes in the school in India.

Hypothesis 8: There will be no significant difference in the overall achievement of chemistry between the student, taught through traditional lecture method of teaching and taught through concept mapping strategy, among the students of secondary classes in the school in Turkey.

Hypothesis 9: There will be no significant difference in the overall achievement of chemistry between the Indian and Turkish students in conceptual learning taught through concept mapping.

1.4. Delimitation

- The present study was limited to the students of IXth class in selected schools only in New Delhi.

- The present study was limited to the students of IXth class in selected schools only in Turkey.
- Only schools of urban area have been taken.
- The study was limited to two schools in India and two schools in Turkey.

2. METHODOLOGY

2.1 The design

In this research, quasi experimental design has been adopted, because, the experimental design was difficult to be used in the classroom situation due to the various limitations. So quasi-experimental design suits best for the present study. Pre-test and post-test non-equivalent group design was used for the problem that is as follow:

O_1 C O_2

O_3 X O_4

O_1 and O_3 are the scores on previous scholastic achievement test conducted before the treatment

O_2 and O_4 are the scores on post-achievement test conducted after the treatment

C is control group i.e., teaching through conventional lecture-demonstration method

X is experimental group i.e., teaching through concept mapping.

The study was conducted on class IXth student. Before the treatment, all groups were administered an achievement test based on concepts of chemistry which the students have learnt in their previous classes.

The students of one section of class IX were taught the concepts of the state of matter, the purification of matter and the structure of atom in chemistry through concept mapping. This group was considered as experimental group. The other group of class IX was considered as control group. The same topics were taught to the students of control group using traditional lecture-demonstration method.

2.2. The sample

The population was the students of class IX of Indian schools and Turkish schools. The sample comprised of 200 students of two different central schools of Delhi and 200 students of two different state schools of Gaziantep. The schools were: Dev Samaj Modern School and Father Agnel School in India, Şehit Şahin Lisesi and Yahya Kemal Beyatli Lisesi in Turkey. Two sections of class IX were taken from each of the four schools. One section served as the control group and the other section as the experimental group.

The experiment consisted of pre-treatment, treatment and post-treatment phases of four weeks duration for Indian school and four weeks duration for Turkish school. At the pre-treatment stage an intelligent test, socio economic status scale and pre-test were administered.

The number of students participated in the study from the two sections of the four schools are shown in the following table.

TABLE I

Schools and Number of Students Participated in the Study

	Schools	Experimental Group	Control Group
School in India	Fr. Agnel School	50	50
	Dev Samaj Moden School	50	50
School in Turkey	Sehit Sahin Lisesi	50	50
	Yahya Kemal Beyatli	50	50
	Total Number of Student	200	200

2.3 The Experiment

Before administrating the tools, the permission of the principle of Father Agnel School and Dev Samaj Modern School, in New Delhi were sought after telling them the plan and purpose of the study. Same procedures have been done for two schools in Turkey. The names of the schools are Sehit Sahin Lisesi and Yahya Kemal Beyatli Lisesi. A schematic presentation of the instructional experimentation is given in Table II

TABLE II

The Schematic Presentation of the Experiment

S.NO	PHASE	ACTIVITY
1	Pre-treatment	All the four groups were administered the following test: a) Intelligence test b) Pre-achievement test in chemistry for class IXth c) Socio-Economic Status Scale (SESS)
2	Treatment	The investigator taught selected course content of chemistry of IXth class to control group and experimental group both, during teaching period. Following instructional methods was used for treatment; • Experimental group : concept mapping model • Control group : conventional lecture-demonstration method
3	Post-treatment	After the treatment, all the groups were administered post-achievement test in chemistry for class IXth

2.4 Instructional Treatment

The instructional treatment was given for four weeks at the rate of 5 periods per week to all the groups. All of these groups were taught the same concepts for the same time duration that each group was taught only one period in one day so that the students might not feel any sort of stress while studying. The instructional treatment was given during the session 2010-2011 of class IXth.

TABLE III

Representing the Units and Sub. Units and Duration Taught During Teaching Chemistry to Students of Class IX.

S. No.	Unit	Concept	Sub-concepts	Duration
1.	Matter in our Surrounding	Matter	(i) Matter is made of particles (ii) Characteristics of particles of matter, Rigid and Fluid (iii) Solid, Liquid and Gases (iv) Diffusion, Melting, Boiling (v) Condensation, Freezing, Sublimation. (vi) Effect of change of pressure, evaporation.	1 hour 1 hour 1 hour 1 hour 1 hour 1 hour
			(i) Pure and Impure substances (ii) Elements (Metal, Non-metals,	1 hour

2.	Is matter around us pure	Pure and Impure substance		Metalloids)	1 hour
			(iii)	Mixtures and Compounds	1 hour
			(iv)	Physical and chemical changes	½ hour
			(v)	Separation of mixture of two solids.	½ hour
			(vi)	Separation of mixture of a solid and a liquid	1 hour
			(vii)	Separation of mixture of two liquids.	1 hour
3.	Structure of Atom	Atom	(i)	discovery of electron, protons and neutron	1 hour
			(ii)	Structure of atom (Theory of atom)	1 hour
			(iii)	Atomic Number, Mass Number,	½ hour
			(iv)	Arrangement of electrons in the atoms.	½ hour 1 hour
			(v)	Valence Elements, Valency of Elements.	1 hour
			(vi)	Isotopes, Radioactive Isotopes, Isobars.	

3. ANALYSIS AND FINDINGS

In the present study the statistical techniques were used such as mean (x), standard deviation (δ), t tests and f tests were used as inferential statistics. Mean is the most satisfactory measure for characterizing a group to determine whether the difference between means of samples is significant.

3.1 Analysis: The Effects of the Concept Mapping on Overall Achievement in Chemistry of Students of Class IX in the Schools in India

The effectiveness of concept mapping as an instructional tool was explored with respect to mean difference of performance achievement test in chemistry.

3.1.1 t-Test

The significance of differences among means is further tested by using t-test.

TABLE IV

Comparison of Control and Experimental Groups on "t" Value (in India)

Group	N	Mean	S.D	Df	Obtained value of "t"	tabulated value of "t" at 0.05 level
Control Group (C_i)	73	25.4	5.85	72	2.3	1.99
Experimental Group (E_i)	73	27.93	7.27	72		

In Table IV the value of t-ratio is found to be significant at 0.05 levels. The obtained value of "t" is higher than the tabulated value of "t" at 0.05 level. Thus concept mapping model is significantly more effective than conventional model on teaching chemistry in IXth class student in India. The comparison of mean values of the two groups indicates that the mean of group E_i (taught through the concept mapping model) differs significantly from the C_i (taught through the conventional method). It can be concluded that group E_i has performed significantly better than group C_i on the dependent variable.

3.1.2 Analysis of Variance

The F value of two groups was found significant. C_i and E_i scores were taken separately as shown in Table V.

TABLE V

Comparison of Control and Experimental Groups on Analysis of Variance (in India)

	S.S	df	MS	obtained value of "F"	tabulated value of "F" at 0.05 level
Between Group	152	1	152	4.53	3.91
Within Group	4829	144	33.53		
Total	4981				

From the table 5.9 obtained value of "F" is 4.53 for df 1/144, tabulated value of "F" at 0.05 level of significance is 3.91. This implies that the difference between the means of control group and experimental group is significant at 0.05 levels of significance. Teaching through concept mapping is effective than conventional method of teaching chemistry in India.

3.2 Analysis: The Effects of the Concept Mapping on Overall Achievement in Chemistry of Students of Class IX in the Schools in Turkey

The effectiveness of concept mapping as an instructional tool was explored with respect to students' performance on achievement test in chemistry of IXth class in Turkey.

3.2.1 t-Test

The significance of differences among means is further tested by using t-test.

TABLE VI

Comparison of Control and Experimental Groups on "t" Value (in Turkey)

Group	N	Mean	S.D	df	Obtained value of "t"	tabulated value of "t" at 0.05 level
Control Group (CT)	91	25.75	7.16	90	2.9	1.98
Experimental Group (ET)	91	28.66	6.37	90		

In table 5.10 the value of t-ratio is found to be significant at 0.05 levels. Thus, concept mapping model is significantly more effective than conventional model in teaching chemistry in IXth class student in India. The comparison of mean values of the two groups indicates that the mean of group E_T (taught through the concept mapping model) differs significantly from the C_T (taught through the conventional method). It can be concluded that group E_T has performed significantly better than group C_T on the dependent variable.

3.2.2 Analysis of Variance

F value was found significant. C_T and E_T scores taken separately as shown in Table VII

TABLE VII

Comparison of Control and Experimental Groups on Analysis of Variance (in Turkey)

	S.S	df	MS	obtained value of "F"	tabulated value of "F" at 0.05 level
Between Group	1542	1	1542	31.06	3.86
Within Group	8936	180	49.64		
Total	10478				

From the table 5.11, the obtained value of F is 31.06.For df 1/180, the tabulated value of F is 3.86 at 0.05 level of significance. This implies that the difference between the means of control group and Experimental groups is significant. Teaching on concept mapping is more effective than conventional method of teaching chemistry in Turkey.

3.3 Analysis: The Effects of the Concept Mapping on Learning Concepts of Chemistry in Terms of Knowledge in India

In this section, the effect of concept mapping as an instructional tool was explored in terms of gain knowledge with respect to mean difference of post achievement test in chemistry.

3.3.1 "t"-Test

The t-test is a special case of ANOVA in which only two means are compared. The significance of differences between two means is tested by using t-test.

TABLE VIII

Comparison of Control and Experimental Groups on "t" value (in India)

Group	N	Mean	S.D	df	Obtained value of "t"	tabulated value of "t" at 0.05 level
Control Group (Ci)	73	9.52	2.58	72	0.106	1.99
Experimental Group (Ei)	73	9.6	2.81	72		

As we can see, in table VIII, the mean of control and experimental group is 9.52 and 9.6 respectively. It is almost similar in figure. On further testing the t-ratio is not found to be significant at 0.05 levels. The obtained value of "t" is lower than the tabulated value of "t" at 0.05 levels. Thus, at first sight the concept mapping model is not significantly more effective than conventional method of teaching in term of gaining knowledge of chemistry in IXth class students in India.

3.3.2 Analysis of Variance

Result of analysis of variance is shown in Table IX.

TABLE IX

Comparison of Control and Experimental Groups on Analysis of Variance (in India)

	S.S	Df	MS	obtain value of "F"	tabulated value of "F" at 0.05 level
Between Group	0.03	1	0.03	0.005	3.92
Within Group	950.46	144	6.6		
Total	950.49				

From the table IX, obtained value of "F" is 0.005, for df 1/144 tabulated value of "F" at 0.05 level of significance is 3.92. It is clear that "F" falls short of the required values of 0.05, so "F" is not significant. This implies that the mean difference between control group and experimental group is not significant at both levels. Teaching through concept mapping is not effective than conventional method of teaching in terms of gain knowledge of students in the schools in India.

3.4 Analysis: The Effects of the Concept Mapping on Learning Concepts of Chemistry in Terms of Knowledge in Turkey

The effect of concept mapping as an instructional tool was explored in terms of knowledge of chemistry with respect to mean difference of post achievement test in chemistry.

3.4.1 "t"-Test

The significance of difference between experimental group and control group is further tested by using t-test.

TABLE X

Comparison of Control and Experimental Groups on "t" Value (in Turkey)

Group	N	Mean	S.D	df	Obtained value of "t"	tabulated value of "t" at 0.05 level
Control Group (C_T)	91	9.62	3.09	90	2.09	1.99
Experimental Group (E_T)	91	10.6	3.58	90		

In table X the value of t-ratio is found to be significant at 0.05 levels. The obtained value of "t" is higher than the tabulated value of "t" at 0.05 level. Thus, concept mapping model is significantly more effective than conventional method of teaching chemistry in IX^{th} class student in Turkey. The comparison of mean values of the two groups indicates that the mean of group E_T (taught through the concept mapping model) differs significantly from the C_T (taught through the conventional method).

3.4.2 Analysis of Variance

The value of F was found significant. Result of the analysis of the variance is shown in table XI.

TABLE XI

Comparison of Control and Experimental Groups on Analysis of Variance (in Turkey)

	S.S	Df	MS	obtained value of "F"	tabulated value of "F" at 0.05 level
Between Group	75.21	1	75.21	6.77	3.86
Within Group	2000.55	180	11.114		
Total	2075.76				

From the table XI the obtained value of "F" is 6.77 for df 1/180, tabulated value of "F"at 0.05 level of significance is 3.86. This implies that the difference between the means of control group and experimental group is significant at 0.05 levels of significance. Here, we may conclude that teaching through concept mapping is significantly more effective than conventional method of teaching in term of gaining knowledge in chemistry school in Turkey.

3.5 Analysis: The Effects of the Concept Mapping on Learning Concepts of Chemistry in Terms of Understanding of Students Studying in Class ix in India

In this section, the effect of concept mapping has been taken as an instructional tool to explore in terms of understanding of the concepts of chemistry, with respect to mean difference of post achievement test in chemistry.

3.5.1 "t"-Test

The significance of differences between two means is tested by using t-test.

TABLE XII

Comparison of Control and Experimental Groups on "t" Value (in India)

Group	N	Mean	S.D	Df	Obtained value of "t"	tabulated value of "t" at 0.05 level
Control Group (Ci)	73	9.15	2.08	72	2.11	1.99
Experimental Group (Ei)	73	9.93	2.4	72		

In table XII the value of t-ratio is found to be significant at 0.05 levels. The obtained value of "t" is higher than the tabulated value of "t" at 0.05 level. The comparison of mean values of the two groups indicates that the mean of the experimental group E_i differs significantly from the mean control group C_i. It can be concluded that group E_i has performed significantly better than group C_i on the dependent variable. Thus, concept mapping model is significantly more effective than conventional model on teaching chemistry in terms of understanding in IXth class student in India.

3.5.2 Analysis of Variance

Result of analysis of variance is as shown in Table XIII.

TABLE XIII

Comparison of Control and Experimental Groups on Analysis of Variance (in Turkey)

	S.S	Df	MS	obtained value of "F"	tabulated value of "F" at 0.05 level
Between Group	41.67	1	41.67	8.61	3.92
Within Group	696.82	144	4.83903		
Total	738.49				

From the table XIII, we can see that the obtained value of "F" is 8.61 for df 1/144 and the tabulated value of "F" at 0.05 level of significance is 3.92. This implies that the difference between the means of control group and experimental group is significant at 0.05 levels of significance. Teaching through concept mapping is significantly more effective than conventional method of teaching in term of understanding in chemistry of students studying in the schools in India.

3.6 Analysis: The Effects of the Concept Mapping on Learning Concepts of Chemistry in Terms of Understanding of Students Studying in Class ix in Turkey

In this section, the effect of concept mapping as an instructional tool was explored in terms of understanding of the concepts in chemistry with respect to mean difference of post achievement test in chemistry.

3.6.1 "t"-Test

The significance of differences between two means is tested by using t-test

TABLE XIV

Comparison of Control and Experimental Groups on "t" Value (in Turkey)

Group	N	Mean	S.D	Df	Obtained value of "t"	tabulated value of "t" at 0.05 level
Control Group (C_T)	91	8.56	3.17	90	2.93	1.99
Experimental Group (E_T)	91	9.88	2.94	90		

In table XIV the value of t-ratio is found to be significant at 0.05 levels of significance. The comparison of mean values of the two groups indicates that the mean of experimental group E_T differs significantly from the mean of C_T. Thus, concept mapping model is significantly more effective than conventional model of teaching chemistry in term of developing understanding of concepts in chemistry in IX^{th} class student in Turkey.

3.6.2 Analysis of Variance

Result of analysis of variance is as shown in Table XV.

TABLE XV

Comparison of Control and Experimental Groups on Analysis of Variance (in Turkey)

	S.S	df	MS	obtained value of "F"	tabulated value of "F" at 0.05 level
Between Group	83.13	1	83.13	9.69	3.86
Within Group	1561.42	180	8.67456		
Total	1644.55				

From the table XV, obtained value of "F" is 9.69 for df 1/180 and the tabulated value of "F" at 0.05 level of significance is 3.86. This implies that the difference between the means of control group and experimental group is significant at 0.05 levels of significance. Teaching on concept mapping is effective than conventional method of teaching in term of developing understanding of concepts in chemistry schools in Turkey.

3.7 Analysis: The Effects of the Concept Mapping on Learning Concepts of Chemistry in Terms of Problem Solving Ability of Students Studying in Class IX in India

The effect of concept mapping as an instructional tool was explored in terms of problem solving ability in chemistry with respect to mean difference of post achievement test in chemistry.

3.7.1 "t"-Test

The significance of difference between experimental group and control group is further tested by using t-test.

TABLE XVI

Comparison of Control and Experimental Groups on "t" Value (in India)

Group	N	Mean	S.D	df	Obtained value of "t"	tabulated value of "t" at 0.05 level
Control Group (Ci)	73	7.22	2.17	72	2.02	1.99
Experimental Group (Ei)	73	8	2.58	72		

In table XVI the value of t-ratio is found to be significant at 0.05 levels. The obtained value of "t" is higher than the tabulated value of "t" at 0.05 levels. The comparison of mean values of the two groups indicates that the mean of experimental group E_i differs significantly from the C_i. It can be concluded that group E_i has performed significantly better than group C_i on the dependent variable. Thus, teaching on concept mapping is significantly more effective than conventional model of teaching chemistry in terms of problem solving ability of students in IX^{th} class in India.

3.7.2 Analysis of Variance

Result of analysis of variance has shown in table XVII.

TABLE XVII

Comparison of Control and Experimental Groups on Analysis of Variance (in India)

	S.S	df	MS	obtained value of "F"	tabulated value of "F" at 0.05 level
Between Group	33.56	1	33.56	6.25	3.92
Within Group	772.95	144	5.36771		
Total	806.51				

From the table XVII we can see that the obtained value of "F" is 6.25 for df 1/144 and the tabulated value of "F" at 0.05 level of significance is 3.92. This implies that the difference between the means of control group and experimental group is significant at 0.05 levels of significance. Hence, it is concluded that teaching through concept mapping is more effective than conventional method of teaching in term of problem solving ability of students studying chemistry in India.

3.8 Analysis: The Effects of the Concept Mapping on Learning Concepts of Chemistry in Terms of Problem Solving Ability of Students Studying in Class IX in Turkey

In this section, the effect of concept mapping as an instructional tool was explored in terms of problem solving ability in chemistry with respect to mean difference of post achievement test in chemistry.

3.8.1 t-Test

The significance of difference between experimental group and control group is further tested by using t-test.

TABLE XVIII

Comparison of Control and Experimental Groups on "t" Value (in Turkey)

Group	N	Mean	S.D	Df	Obtained value of "t"	tabulated value of "t" at 0.05 level
Control Group (Ci)	91	7.14	2.8	90	1.98	1.99
Experimental Group (Ei)	91	7.93	2.59	90		

In Table XVIII, the value of t-ratio is not found to be significant at both levels. The obtained value of "t" is lower than the tabulated value of "t" at 0.05 levels. Thus, the mean difference between concept mapping model and conventional method of teaching does not differ significantly. Thus, teaching through

concept mapping and conventional method of teaching is equally effective in terms of problem solving ability in chemistry in IXth class students of Turkey.

3.8.2 Analysis of Variance

Result of analysis of variance is as shown in Table XIX.

TABLE XIX

Comparison of Control and Experimental Groups on Analysis of Variance (in Turkey)

	S.S	df	MS	obtained value of "F"	tabulated value of "F" at 0.05 level
Between Group	18.48	1	18.48	2.91	3.86
Within Group	1142.75	180	6.34861		
Total	1161.23				

From the table XIX, we have obtained, value of "F" as 2.91, for df 1/180 and the tabulated value of "F" at 0.05 level of significance is 3.86. "F" falls short of the required values at both 0.05 levels of significance, so "F" is not significant. This implies that the mean difference between control group and experimental group is not significant at both levels. Teaching through concept mapping is not effective than conventional method of teaching in terms of problem solving ability in chemistry schools in Turkey.

3.9 A Comparative Analysis to Find out the Effectiveness of Concept Mapping on Student's Achievement in Chemistry in India and Turkey

In this section, the effectiveness of concept mapping was compared on the basis of experimental groups E_I and E_T in two countries. "F" test used for comparing the two groups. The value of F is the base of the conclusion of a significant difference between these two groups.

3.9.1 A Comparative analysis to find out the Effectiveness of Concept mapping on overall achievement of students in chemistry in India and Turkey

F value was compared with the control group in the previous section. In this section, comparison of the two experimental groups will be addressed. . S.S, df, S.M and F value of two groups are given in the Table XX below.

TABLE XX

Comparison of two Experimental Groups (E_I and E_T) on Analysis of Variance

	S.S	df	MS	obtained value of "F"	tabulated value of "F" at 0.05 level
Between Group	21.087	1	21.09	0.45	3.9
Within Group	7633.8	162	47.12		
Total	7654.9				

From the Table XX, we have obtained value of "F" as 0.45, for df 1/162 and the tabulated value of "F" at 0.05 level of significance is 3.9. It is clear that "F" falls short of the required values at 0.05 levels of significance, so "F" is not significant. This implies that the mean difference between two experimental groups is not significant at 0.05 levels. Thus, teaching through concept mapping is equally effective in terms of overall achievement of students in chemistry in India and Turkey.

3.9.2 A Comparative analysis to find out the Effectiveness of Concept mapping in term of knowledge in chemistry in India and Turkey

F values were compared with the control group in the previous section. In this section, comparison of the two experimental groups will be addressed. S.S, df, S.M and F value of two groups are given in the Table XXI below.

TABLE XXI

Comparison of two Experimental Groups (E_I and E_T) on Analysis of Variance

	S.S	df	MS	obtained value of "F"	tabulated value of "F" at 0.05 level
Between Group	44.96	1	44.96	4.49	3.9
Within Group	1622.7	162	10.02		
Total	1667.7				

From the Table 5.25 obtained value of "F" is 4.49 for df 1/162, tabulated value of "F" at 0.05 level of significance is 3.9. This implies that the difference between the means of control group and experimental group is significant at 0.05 levels of significance. The comparison of the difference between E_I and E_T (India and Turkey) indicate that the group E_T has performed significantly better than the group E_I. Teaching through concept mapping is significantly more effective in Turkey than in India in term of knowledge student studying in chemistry in class IX.

3.9.3 A Comparative Approach to the Effectiveness of Concept mapping in term of understanding in chemistry schools in India and Turkey

F values were compared with the control group in the previous section. In this section, comparison of the two experimental groups will be addressed. The S.S, df, S.M and F value of two groups are given in the Table XXII below.

TABLE XXII

Comparison of Two Experimental Groups (E_I and E_T) on Analysis of Variance

Group	S.S	Df	MS	obtained value of "F"	tabulated value of "F" at 0.05 level
Between Group	0.036	1	0.036	0.0002	3.9
Within Group	34042.1	162	210.1		
Total	34042.1				

From the table XXII, we have obtained value of "F" as 0.0002, for df 1/162 and the tabulated value of "F" at 0.05 level of significance is 3.9. It is clear that "F" falls short of the required values at 0.05 levels of significance, so "F" is not significant. This implies that the mean difference between two experimental groups is not significant at 0.05 levels. Thus, teaching through concept mapping is equally effective in terms of understanding in chemistry schools in India and Turkey.

3.9.4 A Comparative Approach to the Effectiveness of Concept mapping in Terms of Problem Solving Ability in Chemistry Schools in India and Turkey

F values were compared with the control group in the previous section. In this section, comparison of the two experimental groups will be addressed. . The S.S, df, S.M and F value of two groups are given in the Table XXIII below.

TABLE XXIII

Comparison of Two Experimental Groups (E_I and E_T) on Analysis of Variance

	S.S	df	MS	obtained value of "F"	tabulated value of "F" at 0.05 level
Between Group	4.04	1	4.04	0.67	3.9
Within Group	983.9	162	6.073		
Total	987.9				

From the Table XXIII, we have obtained value of "F" as 0.67, for df 1/162 and the tabulated value of "F" at 0.05 level of significance is 3.9. It is clear that "F" falls short of the required values at 0.05 levels of significance, so "F" is not significant. This implies that the mean difference between two experimental groups is not significant at 0.05 levels. Thus, teaching through concept mapping is equally effective in terms of problem solving ability in chemistry schools in India and Turkey.

4. CONCLUSIONS

1. Concept mapping as an instructional tool is significantly more effective than conventional method of teaching in the overall achievement of chemistry in IXth class student of India.
2. Concept mapping as an instructional tool is significantly more effective than conventional method of teaching in the overall achievement of chemistry in IXth class student of Turkey.
3. Teaching through concept mapping and conventional method of teaching is equally effective in chemistry in terms of gaining knowledge in IXth class student in the schools of India.
4. Teaching through concept mapping is significantly more effective than conventional method of teaching in chemistry in terms of gaining knowledge in IXth class student in the schools of Turkey.
5. Concept mapping model is significantly more effective than conventional method of teaching in chemistry in terms of understanding in IXth class student in India.
6. Concept mapping model is significantly more effective than conventional method of teaching in chemistry in term of understanding in IXth class student in Turkey.
7. Teaching of concept mapping is significantly more effective than conventional model of teaching in the students' ability to solve problem related to chemistry in IXth class students' schools in India.

8. Teaching through concept mapping and conventional method of teaching is equally effective in the students' ability to solve problem related to chemistry in IXth class students' schools in Turkey.
9. Teaching through concept mapping is equally effective in terms of overall achievement of students in chemistry in India and Turkey.
10. Teaching through concept mapping is significantly more effective in Turkey than in India in term of knowledge student studying in chemistry in class IX.
11. Teaching through concept mapping is equally effective in terms of understanding in chemistry schools in India and Turkey.
12. Teaching through concept mapping is equally effective in terms of problem solving ability in chemistry schools in India and Turkey.

5. IMPLICATIONS

The findings and conclusions of the present study indicate that concept mapping strategy is more effective than the conventional method in teaching chemistry concepts to the secondary school students (IXth class). These effects are being measured in terms of overall achievement, knowledge, understanding and problem solving ability. The conclusion comprise from this study is that these implications are very important for the classroom teaching.

5.1 Implication for students

In conventional method of teaching, the concepts are presented to the students in isolation and students are expected to learn concepts in a given sequence irrelative to the students' own previous knowledge. Students try to memorize the given concepts without propose and may acquire information without structure or without reproducing new information. In this condition the students are incapable of flexible and critical thinking, this reflect the poor condition of the students in term of knowledge, understanding and problem solving ability as mentioned in this study.

Concept maps allow students to think deeply about the concepts by helping them to understand better and organize what they learn, and to store and retrieve information more smoothly and efficiently. Students also articulate and challenge their thoughts about chemistry when they discuss their maps with each other.

Thus, concept mapping model has tremendous implications for learners and may be a suitable means to enable a student in overall achievement.

5.2 Implication for teacher

The findings of the present study indicate that concept maps may be used as an effective teaching tool in schools in the subject of chemistry. It is important for the teacher to identify sub-concepts, arrange them hierarchically and establish valid inter-relationships, to teach a concept. The teachers can design lesson sequences that allow one proposition to follow naturally from the other; thus, encourages meaningful learning. The teachers may design concept map as student-centered, active teaching tool in the class. It can encourage student-teacher interaction when they create a map together by discussing.

Concept maps can help teachers to identify, understand, and organize chemistry concepts we plan to present in the classroom. The teaching event may be a lecture, discussion or laboratory activity. It should be noted that it is time consuming process; each student has a different capacity and time period to handle this method. Instructors shouldn't give up in such cases.

As a science teacher, we should emphasize the quality of students' understandings rather than their test scores. Conceptual understanding is crucial and it should be a focus of our interest in science teaching. We need to promote conceptual learning over rote learning.

6. SUGGESTIONS FOR FURTHER STUDIES

Based on the findings of the present study, following suggestions are made for further researches in this area;

- This study covered a small number of chemistry concepts of class IX. Similar studies can be conducted taking wider content area not only in chemistry but in other subjects, disciplines and interdisciplinary courses as well.
- This study was conducted and based on a small sample, e..g. taken two schools from India and two schools from Turkey. Similar studies may be conducted on a larger sample taken from a number of schools. This could enhance reliability of results.
- This study comparing effectiveness of concept mapping was conducted in government /public schools of urban area. Other studies can be conducted in school in rural area for making wider generalizations.
- The present study focused on theoretical achievement in chemistry. Studies may be comprised of practical (laboratory) achievement in chemistry subject.
- The present researcher (a single teacher) administered the treatment in the present study. The subsequent studies could be replicated by involving larger number of teacher in the experiment.

- The sample of the present study comprised of intact groups. Studies may be designed in which subjects are randomly assigned to groups. This will increase the external validity of the design.
- In the present study, there was a purposive sampling. Other studies can be conducted by selecting the samples randomly. This would increase external validity of the experiment.
- This study was conducted at secondary level. Other studies can be conducted at middle, senior secondary and college level. Such studies establish the generalizability of the concept mapping achievement in chemistry.

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