

Effect of Concept Mapping Strategy on Achievement in Chemistry of IX Graders in Relation To Gender

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Abstract: *The study was carried out to investigate the effect of teaching through Concept mapping on the achievement in Chemistry in relation to gender. Sample of the study consisted of 236 (118 experimental group and 118 controlled group) IX class students from four Government schools of Ludhiana city. Experimental group was exposed to Concept mapping method and the controlled group was exposed to Conventional method (lecture and discussion). Mixed group intelligence test (MGTT) by Mehrotra (2008) was used to match the groups. Achievement test in Chemistry (developed and standardized by the investigator) was used as tool for data collection. The results of the study showed that achievement in Chemistry of the group taught by Concept mapping was significantly more as compared to group taught by Conventional method. It was also found that boys and girls of experimental group do not differ in their achievement in Chemistry.*

Keywords: Concept Mapping, Experimental Group, Controlled Group, Achievement in Chemistry, Gender.

1. Introduction

As the 21st century is the era of change as everything is changing at the faster pace. To satisfy the needs of students of the 21st century new experiments, creative innovations, and appropriate strategies are being developed and tried out to improve education at all levels. Concept mapping is also the new emerging strategy.

Originally the Concept mapping method was developed by Novak at Cornell University in the 1960s. This concept emerges in the field of learning after new school of constructivism, which accepts active participation of the learner in construction of knowledge. The constructivist learning theory, with its roots in the learning theory of Ausubel, Novak and Hanesian (1978) clearly states that every learner actively builds or constructs her or his own private understanding of the world.

In order to be successful in learning, students have to take possession of knowledge actively by seeking expert conceptual linkages between new concepts and those, they already possess. More simply, knowledge is constructed in the mind of the learner (Bodner, 1986). The task of knowledge representation has two parts: the first is to analyze body of knowledge and identify the relevant concepts, relations, and assumptions; the second is to translate the result of the analysis into some notation that can be processed. Neither part is easy, but the first is far more difficult (Sowa, 2006).

Concept mapping is the unique way of representing information. There are three features used in creating concept maps: (a) a list of concepts, (b) lines that represent the relational links between these concepts, and (c) labels for these linking relationships. Concept maps are frequently employed in the classroom because they offer a "complementary alternative to natural language as a means to communicate knowledge" (Gaines & Shaw, 1995). This visual approach has proven to be of great benefit to diverse student groups.

The procedure of Concept mapping starts with the generation of a list of concepts through brainstorming. Connecting lines are drawn between these concepts to indicate the flow of interrelationship between concepts which may result in a knowledge structure. These maps can be refined by many rethinking and redrawing processes as more knowledge is accumulated form a search (Novak, 1995).

According to Random House Webster's College Thesaurus (1997) Academic Achievement means those qualities or attributes or characteristics or traits of an individual which contribute to or have a learning or effect or influence or accomplishment or proficient of performance pertaining to any activity scholastic in nature. According to Dictionary of Education (2008), "Academic achievement is a measure of knowledge gained through formal education usually indicated by test scores, grade point average and degree."

2. Review of Related Literature

Teaching through Concept mapping and Achievement: Studies on Concept mapping by Montiel (1980), Pankratius (1990), Jegede and Okebukola (1990), Stensvold and Wilson (1992), Guastello et al. (2000), Ritchie and Volkl (2000), Sungur et al. (2001), Chang and Chen (2002), Novak (2002), Preszler (2004), Snead and Snead (2004), Wang and Dwyer (2004), Novak and Canas (2006), Asan (2007), Ling and Boo (2007), Aydin et al. (2009), Chiou (2009), Okoye and Karakuyu (2010), Awofala (2011), Dosanjh (2011), Akay et al. (2012), Sood (2012), Vaishnav (2012), Jack (2013), Julius and Wachanga (2013), Jena (2014), Fatokun and Eniayeju (2014), found that teaching through Concept Mapping has significant positive effect on the achievement of the students but the studies of Brandt et al. (2001), Deyu Hu (2006), Adlaon (2012), Abdulkarim and Hassan (2013) found no significant differences in the academic achievement between Concept Mapping and traditional method.

Achievement and Gender: Bilesanmi-Awoderu (2006) investigated the relative effectiveness of Concept mapping and lecture methods on the academic achievement of

Nigerian High School Studies in Biology using gender and locus of control as intervening variables. The results showed that the concept mapping strategy is more effective in enhancing students' achievement in Biology than the lecture method. However, there was no significant main effect of gender on the treatment. The results of Okoye and Okechukwu (2010) showed that the concept-mapping strategy is more effective in enhancing students' achievement in biology than the lecture method. However, there was no significant main effect of gender on the treatment., other supporting studies were of Simon (2007), Ezeudu (2013), Abdulkarim and Hassan (2013) which revealed that there was no gender influence on students' concept-mapping ability and their achievement in the subject.

Justification of the Problem: Most of the studies had been undertaken only in foreign countries. As compared to advance countries very less research work has been done in India. Only five studies had been found in Panjab University covering the population of Chandigarh (Kumar, 2009; Sharma, 2010; Rani, 2011; and Sood, 2012), Amritsar (Aggarwal, 2012), Kapurthala (Jena, 2014) on effectiveness of Concept mapping. But, no study has been found specifically done on the population of Punjab Government school students on subject of Chemistry. The proposed study thus seems fully justified as it checks the effect of teaching through Concept Mapping on achievement in Chemistry of grade IX on Punjab Government school students in relation to gender.

3. Objectives

- 1) To investigate the significance of difference in Achievement in Chemistry of the group taught through Concept mapping and Conventional teaching.
- 2) To investigate the significance of difference in Achievement in Chemistry of the boys and girls taught through Concept mapping.

4. Hypotheses

H0 1 There will be no significant difference in Achievement in Chemistry of the group taught through Concept mapping and Conventional teaching.

H0 2 There will be no significant difference in Achievement in Chemistry of the boys and girls taught through Concept mapping.

5. Method and Procedure

To study the effectiveness of Concept mapping strategy on the Achievement in Chemistry in relation to gender, randomized two group pretest- posttest design was used. Here in the first phase Chemistry achievement test was constructed and standardized; concept maps were also constructed. Two groups A1 and A2 Experimental and Controlled groups were matched with the test of intelligence. In the second phase Chemistry achievement test was applied as a pre test. In the third phase students of Experimental group and Controlled were exposed to Concept mapping method and Conventional teaching respectively. In the last

phase Chemistry achievement test was applied again as a post test. The difference of scores of pre and post test which is termed as mean gain scores is index with which effectiveness of two methods could be compared.

Variables of the Present Study

The investigators had taken two strategies, traditional (Lecture and discussion) method and Concept mapping strategy as an independent variable. Gender was taken as classificatory variable. This variable classified the sample of students in two categories on the basis of gender i.e. boys and girls while acquisition of Chemistry concepts (Achievement) was considered as dependent variable. This was evaluated by the mean gain scores i.e. the difference of Post-test scores and Pre-test scores of students in the Achievement test in Chemistry.

Control: Various steps were taken to control the extraneous variables. Control was applied with regard to Selection of sample by adopting method of randomization, students were matched on the basis of intelligence, age group of the students was also considered along with their socio-economic status, nature and subject mastery of the teacher was controlled as investigator herself taught both the groups, thus teacher was the other factor wherein control was applied. The analysis was done on the gain scores in order to eliminate the effect of the prior knowledge about the subject. Only Government schools were taken for the sampling, so the effect of environmental factor was nullified. Investigators made students comfortable with respect to medium. For this purpose Chemistry achievement test was translated and revalidated in all the three languages-English, Hindi and Punjabi.

Sample of the study: For the study, sample of 236 students of 9th class were selected through the randomization technique from four Government schools of Ludhiana city. Here 118 students were taken as experimental group and other 118 students were taken as controlled group.

Tools

- (a) Mixed group intelligence test by Mehrotra (2008)
- (b) Achievement test in Chemistry (developed and standardized by the investigator)

6. Results and Discussion

The result is discussed in Part I and Part II given below:

Part I- Matching of the groups: The Experimental and Controlled groups were matched on the basis of Intelligence. The t-ratios were worked out and the values are given in table 1:

Table 1: Matching on the basis of intelligence

Group	N	Mean	Standard Deviation	t-ratio
Experimental	118	32.59	8.481	0.24
Controlled	118	32.29	9.646	(N.S.)

N.S. means non-significant (value of t-ratio significant at 0.05 level = 1.96)

Table 1 reveals that mean scores of the Experimental group (group taught through Concept mapping method) for intelligence is 32.59 and Standard deviation for the same is 8.481 where as mean scores of the Controlled group (group taught through Conventional method) for intelligence is 32.29 and Standard deviation for the same is 9.646. The value of t-ratio came out to be 0.24 which is non-significant ($p > 0.05$). Thus there exists no significant difference in both the groups with respect to intelligence, i.e. groups are matched on intelligence.

Part II (a) Hypothesis 1: Significance of difference in Achievement in Chemistry of the group taught through Concept mapping and Conventional teaching:

To investigate the significance of difference in Achievement

in Chemistry of the group taught through Concept mapping and Conventional teaching t-test was applied between mean gain scores of students of Experimental group and Controlled group. The values are given in table 2(a) and table 2(b) below:

Table 2 (a): Group Statistics

Group	N	Mean	Standard Deviation	Standard Error of Mean
Experimental	118	19.18	7.193	0.662
Controlled	118	10.36	6.002	0.553

Table 2(b): Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig.(2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Gain Scores	Equal variances assumed	3.617	0.71	-10.574	234	.000	-9.119	0.862	-10.82	-7.420
	Equal variances not assumed			-10.574	226.73	.000	-9.119	0.862	-10.82	-7.419

Table 2 (a) reveals that mean of achievement in Chemistry of the Experimental group is 19.18 whereas mean of achievement in Chemistry of the Controlled group is 10.36 respectively. On application of F-test through SPSS Table 2(b) table of independent sample test is obtained, this table reveals results of two tests-Levene's Test for equality of variances and t-test for equality of means. The table contains two sets of analysis, the first one assuming equal variances in the two groups and the second one assuming unequal variances. Above table reveals that F value is 3.617 and $P=0.71$ which is non-significant at 0.05 level of significance. It indicates that the two groups have equal variances. Therefore, the statistics associated with equal variances assumed should be used for the t-test for equality of means. The t-test results (with equal variances assumed) show t value is 10.574 with 234 degrees of freedom the corresponding two tailed p-value is 0.00, which is less than 0.01. Therefore the null hypothesis is rejected at 1% level of significance, which means that the students of Experimental and Controlled groups significantly differ in their achievement in Chemistry i.e. students of Experimental group (Mean = 19.18) are significantly better in achievement in Chemistry than the students of Controlled group (Mean = 10.36).

Part II (b) Hypothesis 2: Significance of difference in Achievement in Chemistry of the boys and girls taught through Concept mapping.

In order to check significance of difference in achievement in Chemistry of the boys and girls taught through Concept mapping, t-test was applied. The obtained values are shown in table 3

Table 3

Group	N	Mean	Standard Deviation	t-ratio
Experimental Girls	59	18.80	6.144	0.64* (N.S.)
Experimental Boys	59	19.56	8.144	

N.S. means non-significant (value of t-ratio significant at 0.05 level = 1.96)

7. Result and Discussion

It can be concluded that Concept mapping method of teaching has a significant effect on the achievement in Chemistry over Conventional teaching but this method has no significant effect on the gender with regard to achievement in Chemistry.

In other words we can say the students who were taught with Concept mapping method gained significantly better than the other group who were taught with traditional teaching method, hence the importance of Concept mapping method can be established (Qarareh, 2010) but the method is beneficial irrespective of gender. Apart from this there is empirical support for the use of mapping in enhancing, retaining and improving knowledge (Davis, 2010). Cognitive Science shows that visual display enhances learning (Winn, 1991; Vekiri, 2002). For many people maps are much easier to follow, it promotes deep and not surface approaches to learning (Biggs, 1987; Ramsden, 1992).

8. Educational Implications of the Study

Results of present study supported that Concept mapping is useful for teaching Chemistry concepts. As there was no significant difference between the achievement of Chemistry

of boys and girls of experimental group so it's clear that the strategy is equally beneficial for both the sexes hence it could be applied in the classroom to increase the achievement of all students. Hence Concept mapping technique is thus strongly recommended for teaching Chemistry in Government Schools of Punjab.

References

- [1] Abdulkarim R. & Hassan, K.A. (2013). The effect of using concept mapping in teaching Physics on academic achievement of the first year students in Oman. *Scottish Journal of Arts, Social Sciences and Scientific Studies*, 10(1), 3-15. Retrieved from <http://scottishjournal.co.uk>
- [2] Adlaon, R.B. (2012). *Assessing effectiveness of concept map as instructional tool in high school Biology*. (Unpublished Master's dissertation in Natural Sciences), Louisiana State University and Agricultural and Mechanical College, Baton Rouge, Louisians.
- [3] Aggarwal, A. (2012). *Effectiveness of computer based concept mapping in acquisition of concept of chemistry in relation to attitude towards science*. (Unpublished Ph.D. thesis in Education), Panjab University, Chandigarh.
- [4] Akay, S.O., Kaya, B., & Kılıç, S. (2012). The effects of concept maps on the academic success and attitudes of 11th graders while teaching urinary system. *International Journal of New Trends in Arts, Sports & Science Education*, 1(3), 55-62. Retrieved from <http://www.ijtase.net/ojs/index.php/IJTASE/article/view/84/112>.
- [5] Asan, A. (2007). Concept mapping in Science class: A case study of fifth grade students. *Educational Technology and Society*, 10(1), 186-195.
- [6] Ausubel, D.P., Novak, J.D., & Hanesian, H. (1978). *Educational Psychology: A*
- [7] Awofala, A.O.A. (2011). Effect of concept mapping strategy on students' achievement in Junior Secondary School Mathematics. *International Journal of Mathematics Trends and Technology*, 2(3), 11-16. Retrieved from www.ijmtjournal.org/Volume-2/issue-3/IJMTT-V2I3P504.pdf
- [8] Aydin, S., Aydemir, N., Boz, Y., Cetin-Dindar, A., & Bektas, O. (2009). The contribution of constructivist instruction accompanied by concept mapping in enhancing pre-service Chemistry teachers' conceptual understanding of Chemistry in the laboratory course. *Journal of Science Education and Technology*, 18(6), 518-534. Retrieved from eric.ed.gov/?id=EJ863601
- [9] Biggs, J. (1987). *Student approaches to learning and studying*. Hawthorn, Vic: Australian Council for Educational Research (ACER).
- [10] Bilesanmi-Awoderu, J.B. (2006). Effect of computer-assisted instruction and simulation/games on the academic achievement of secondary school students' in Biology. *Sokoto Educational Review*, 8(1), 49-60.
- [11] Bodner G. (1985). Constructivism: a theory of knowledge. *Journal of Chemical Education*, 63(10):873-877. Retrieved from chemed.chem.purdue.edu/bodnergrouppdf/24_Construct.pdf
- [12] Brandt, L., Elen, J., Hellemans, J., Heerman, L., Couwenberg, I., Volckart, L., & Morisse, H. (2001). The impact of concept mapping and visualization on the learning of secondary school Chemistry students. *International Journal of Science Education*, 23(12), 1303-1313. Retrieved from http://www.stanford.edu/dept/SUSE/projects/ireport/articles/concept_maps/the%20impact%20of%20visual%20concept%20map.pdf
- [13] Chang, K.S.Y., & Chen, I. (2002). The effect of concept mapping to enhance text comprehension and summarization. *The Journal of Experimental Education*, 71(1), 5-23. Retrieved from ir.lib.ntnu.edu.tw/bitstream/.../2/metadata_0111004_01_046.pdf?..
- [14] Chawla, J., & Singh, G. (2015). Effect of Concept Mapping strategy on achievement in Chemistry of IX graders in relation to Achievement Motivation. *Asia Pacific Journal of Research*, 1(XXIV), 53-65.
- [15] Chiou, C.C. (2009). Effects of concept mapping strategy on learning performance in Business and Economics Statistics. *Teaching in Higher Education*, 4(1), 55-69. Retrieved from www.tandfonline.com > List of Issues > Table of Contents
- [16] Davis, M. (2010). *Concept mapping, mind mapping and argument mapping: what are the differences and do they matter?* Retrieved from http://www.academia.edu/448864/Mind_Mapping_Concept_Mapping_Argument_Mapping_What_are_the_differences_and_Do_they_Matter
- [17] Deyu Hu (2006). *The effects of scaffolding on the performance of students in Computer-based concept linking and retention of comprehension*. {Unpublished Ph.D. thesis in Curriculum and Instruction, (Instructional Design and Technology)}, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.
- [18] *Dictionary of Education. Online Oxford (2008)*. New York: Oxford University Press.
- [19] Dosanjh, N.K. (2011). *The effects of three concept mapping strategies on seventh-grade students' science achievement at an urban middle school*. ProQuest Dissertations and Theses; thesis (Ed.D.)--University of San Francisco. Retrieved from <http://gradworks.umi.com/34/65/3465591.html>
- [20] Ezeudu, F.O. (2013). Influence of concept maps on achievement retention of senior secondary school students in Organic Chemistry. *Journal of Education and Practice*, 4(19), 35-43. Retrieved from www.iiste.org
- [21] Fatokun, K.V.F., & Eniayeju, P.A. (2014). The effect of concept mapping- guided discovery integrated teaching approach on Chemistry students' achievement and retention. *Educational Research and Review*, 9(22). 1218-1223. Retrieved from <http://www.academicjournals.org/journal/ERR/article-abstract/BD662D148681>
- [22] Gaines, B.R., & Shaw, M.L.G. (1995^a). Concept maps as hypermedia components, knowledge Science Institute, University of Calgary. Retrieved from <http://ksi.cpsc.ucalgary.ca/articles/ConceptMaps/>
- [23] Guastello, E.F., Beasley, T.M., & Sinatra, R.C. (2000). Concept mapping effects on Science content comprehension of low-achieving inner-city seventh graders. *Remedial and Special Education*, 21, 356-366.

- Retrieved from rse.sagepub.com/content/21/6/356.abstract
- [24] Jack, G.U. (2013). Concept mapping and guided inquiry as effective techniques for teaching difficult concepts in Chemistry: Effect on students' academic achievement. *Journal of Education and Practice*, 4(5), 9-14. Retrieved from www.iiste.org
- [25] Jegede, O.J., Alaiymola, F.F., & Okebukola, P.A. (1990). The effect of concept mapping on students' anxiety and achievement in Biology. *Journal of Research in Science Teaching*, 27(10), 951-960. Retrieved from onlinelibrary.wiley.com/doi/10.1002/tea.3660271004/pdf
- [26] Jena, P.C. (2014). Effect of concept mapping on the academic achievement of rural secondary school students in Mathematics. *Scholars Journal of Arts, Humanities and Social Sciences*, 2(1), 106-109. Retrieved from <http://saspjournals.com/sjahss>
- [27] Karakuyu, Y. (2010). The effect of concept mapping on attitude and achievement in a Physics course. *International Journal of Physical Sciences*, 5(6), 724-737. Retrieved from <http://www.academicjournals.org/journal/IJPS/article-abstract/536E2A726759>
- [28] Kumar, V. (2009). *Relative effectiveness of concept mapping and concept attainment model of instruction in relation to study habits and style of learning and thinking*. (Unpublished Ph.D. thesis in Education), Panjab University, Chandigarh.
- [29] Ling, Y., & Boo, H.K. (2007). Concept mapping and pupils' learning in primary Science in Singapore. *Asia-Pacific Forum on Science Learning and Teaching*, 8(2), 11. Retrieved from https://repository.nie.edu.sg/bitstream/10497/.../1/APFSLT-8-2-11_a.pdf
- [30] Mehrotra, P.N. (2008). *Manual of mixed type group test of intelligence (MGTI)*. Agra: National Psychological Corporation.
- [31] Montiel (1980). Implementation and evaluation of a P.S.I. mastery based curriculum in general studies for the Colegio Universitario De Cabinas, Venezuela. *Dissertation Abstract International*, 41(11), 4595 A.
- [32] Novak, J.D. (1995). Concept mapping to facilitate teaching and learning. *Prospects*, XXV(1), 79-85. Retrieved from link.springer.com/article/10.1007%2FBF02334286
- [33] Novak, J.D. (2002). Meaningful learning: The essential factor for conceptual change in limited or appropriate propositional hierarchies leading to empowerment of learners. *Science Education*, 86(4), 548-571. Retrieved from online.library.wiley.com/doi/10.1002/sce.10032/abstract
- [34] Novak, J.D., & Canas, A.J. (2006). *The theory underlying concept maps and how to construct them*. Technical Report IHMC C-map Tools 2006-01, Florida Institute for Human and Machine Cognition, 2006. Retrieved from <http://cmap.ihmc.us/publications/ResearchPapers/TheoryUnderlyingConceptMaps.pdf>
- [35] Nwagbo, C., & Okonkwo, I. (2014). Effect of concept mapping teaching strategy on students' achievement in Environmental concepts in Chemistry, *International Journal of Scientific Research*, 3(4), 61-63. Retrieved from [http://theijournal.com/ijournal/file.php?val=April_2014_1396444542_131fa_23.pdf](http://www.theijournal.com/ijournal/file.php?val=April_2014_1396444542_131fa_23.pdf)
- [36] Okoye, N.S., & Okechukwu, R.N. (2010). The effect of concept mapping and problem solving teaching strategies on achievement in Biology among Nigerian secondary school Students. *Academic Journal Education*, 131(2), 288-294. Retrieved from www.eric.ed.gov/ERICWebPortal/recordDetail?accno=EJ930626
- [37] Pankratius, W.J. (1990). Building an organized knowledge base: Concept mapping and achievement in secondary school Physics. *Journal of Research in Science Teaching*, 27(4), 315-333. Retrieved from doi: 10.1002/tea.3660270404
- [38] Preszler, R. (2004). Cooperative concept mapping: Improving performance in undergraduate Biology. *Journal of College Science Teaching*, 33(6), 30-35. Retrieved from eric.ed.gov/?id=EJ752487
- [39] Qarareh, A.O. (2010). The effect of using concept mapping in teaching on the achievement of fifth graders in Science. *Studies on Home and Community Science*, 4(3), 155-160. Retrieved from www.krepublishers.com/.../HCS-4-3-155-10-127-Qarareh-A-O-Tt.pdf
- [40] Ramsden, P. (1992). *Learning to teach in higher education*. London, NJ: Erlbaum.
- [41] *Random House Webster's College Thesaurus* (1997). New York: Random House Reference & Information Publishing.
- [42] Rani, L. (2011). *Effect of concept mapping on science achievement among IX graders in relation to test anxiety and self efficacy*. (Unpublished Ph.D. thesis), Panjab University, Chandigarh.
- [43] Ritchie, D., & Volkl, C. (2000). Effectiveness of two generative learning strategies in the Science classroom. *School Science and Mathematics*, 100(2), 83-89. Retrieved from onlinelibrary.wiley.com/doi/10.1111/j.1949-8594.2000.tb17240
- [44] Sharma, J. (2010). *A study on acquisition of environmental awareness through concept mapping among IX graders in relation to achievement motivation and cognition styles*. (Unpublished Ph.D. thesis), Panjab University, Chandigarh.
- [45] Simon, J. (2007). Concept mapping in a Financial Accounting Theory Course. *Accounting Education*, 16(3), 273-308. Retrieved from [www.tandfonline.com > List of Issues > Table of Contents](http://www.tandfonline.com/ListofIssues/TabofContents)
- [46] Snead, D. & Snead, W.L. (2004). Concept mapping and Science achievement of middle grade students. *Journal of Research in Childhood Education*, 18(4), 306-308. Retrieved from eric.ed.gov/?id=EJ751933
- [47] Sood, P. (2012). *Effect of video assisted instruction and computer based Concept Mapping on achievement in Mathematics in relation to emotional intelligence and attitude towards technology*. (Unpublished Ph.D. thesis in Education), Panjab University, Chandigarh.
- [48] Sowa, J. (2006). *Concept mapping*. Talk presented at the Area Conference San Francisco. <http://www.jfsowa.com/talks/cmapping.pdf>
- [49] Stensvold, M. & Wilson, J.T. (1992). Using concept maps as a tool to apply Chemistry concepts to

- laboratory activities. *Journal of Chemistry Education*, 69(3), 230-232.
- [50] Sungur, S., Tekkaya, C. & Geban, O. (2001). The contribution of conceptual change texts accompanied by concept mapping to students' understanding of the human circulatory system. *School Science and Mathematics*, 101(2), 91-101. Retrieved from www.Stanford.edu/.../concept maps/
- [51] Vaishnav, R.S. (2012). Effect of concept mapping on achievement of trainee teachers of B.Ed. course. *Voice of Research*, 1(3), 22-26.
- [52] Vekiri, I. (2002). What is the value of graphical display in learning? *Educational Psychological Review*, 14(3), 261-312. Retrieved from www.researchgate.net/... What Is the Value of Graphical Displays in
- [53] Wang, C.X., & Dwyer, F. (2004). Effect of varied concept mapping strategies on student achievement of different educational objectives. *International Journal of Instructional Media*, 31(4), 371-382. Retrieved from eric.ed.gov/?id=EJ725518
- [54] Winn, W. (1991). Learning from maps and diagrams. *Educational Psychological Review*, 3(3), 211-247. Retrieved from [link.springer.com/article/10.1007 % 2 BFB01320077](http://link.springer.com/article/10.1007%2FBF01320077)

