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# The Effect of Instruction Using the Concept Map on the Degree of Critical Thinking and Reasoning, Learning, and Retention of the Students

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**Abstract:** The purpose of the present research is to investigate and compare the effect of instruction on the degree of critical thinking and reasoning, learning, and retention of students at B.A. level in Shahid Beheshti Training College in Gonbad Kavus using the Concept Map teaching model and the current (traditional) method. The quasi-experimental research plan was applied on two groups (n1=20, n2=20) so that the following question can be answered: Are there any differences statistically between the performances of the students instructed in the two methods concerning their critical thinking, reasoning, learning, and retention? The sample body consisted of 40 people, and it was calculated using the Cochran formula. Students in the two groups learned the course "principles of Education" through the Concept Map model and the current (traditional) method respectively. For collecting data, a researcher-made test on learning, another one on retention, and the Californian Critical Thinking Questionnaire were used, all of which put into practice after their validities and reliabilities were confirmed in two stages, i.e. before and after the experiment. The gathered data was analyzed using the t-test to compare the independent means and the covariance analysis in order to control the pretest effect. Results showed that the learning and retention performance of the students who had been instructed in the Concept Map model is higher than that in the intact (control) group, and the Concept Map model has been more effective than the current method in critical thinking as well.

**Key Words:** Concept Map, Teaching Model, Learning, Retention, Critical Thinking.

The present age technology is proceeding with a dazzling speed, and the human society needs ingenious, creative, and innovative individuals more than any other time. One of the duties of an education system is to train people who own critical, creative minds, and are able to solve problems and untie knots and intricacies, not those who accumulate the information and knowledge that become obsolete rapidly (Sarhangi, et al, 2010, p.1). Critical thinking is a complicated mental activity that has been described in different ways. Glasman (1984) has defined critical thinking as the ability to recognize and organize problems, using deductive and inductive reasoning, the ability of a rational extraction of information gained from different sources, defending people's logical conclusions, and the ability to distinguish between facts and beliefs. Ennis (1985) believes that thinking is critical when the thinker tries to carefully look for valuable evidence and attain sound judgments and results in the analysis of issues. He regards the goal of teaching critical thinking as training human beings who avoid personal grudges, and are committed to frankness and precision (cited in Shabani and Mehrmohammadi, 2000).

In recent years, scholars in education science have expressed concern about students' thinking incapability. Undoubtedly, the development of complicated thinking abilities is essential for human success in the 21st century. Many authorities on critical thinking such as Robert Ennis, Paul, Lipman, and Myers believe that one of the essential goals of education should be to train thoughtful human beings (Yusefi Sa'idabadi, Yazdanpanah Nozari, and Qasemi, 2009, p. 89). Therefore, the ultimate and overall goals of education should inevitably change, since lecturing, as the dominant method in many education centers, fosters a passive learning style in which critical thinking is never or just implicitly taught (Nales, cited in Khalili, Babamohammadi, and Hajiaqajani, 2003, p. 54).

Today, education theorists have come to the conclusion that applying teaching methods enhancing meaningful learning causes more learning in learners and also heightens critical and creative thinking skills in them. These changes have raised educators' hopes to cause meaningful and profound learning in their students instead of superficial learning. The concept map method is one of the modern educational strategies, having an important role in this field (Rahmani, et al, 2009, p. 42).

Concept maps demonstrate our thinking and understanding, and are indicators of our views on our knowledge and its relationships. Using

concept maps as an educational strategy was first initiated by Novak in early 1980's. This method has been adopted from the idea of advance organizers in Ausubel's theory of meaningful learning in which the role of learner's previous knowledge in the following meaningful learning is highly emphasized (Mesrabadi, Fathi'azar, and Ostovar, 2005, p. 13). This method can be used in all stages of instruction, from planning and preparing the curriculum up to its being performed and evaluated (Sunn, cited in Abbasi, et al, 2008, p. 32).

Many recent researches such as Nejat, Kuhestani, and Reza'i (2011), Sarhangi, et al (2010), Qanbari, Paryad, and Ehsani (2010), Mesrabadi and Ostovar (2009), Abbasi, Mirza'i, and Hatami (2008), Mesrabadi, Hosseini Nasab, Fathi'azar, and Moqaddam (2007), Tseng, et al (2011), Liu, Chen, and Chang (2010), have inspected the use of concept maps in education. Basically, the question in these researches has been whether teaching in the concept map method can facilitate learning. The results demonstrate successful examples of this type of instruction.

Rahmani, et al (2007) in a research titled "The Comparison of the Effect of Instruction on Learning Based on Concept Maps and the Integration Method" found out that both methods were effective in the enhancement of knowledge and meaningful learning of students, but the means of two groups before and after instruction had a significant difference statistically only in meaningful learning. They suggest that concept mapping be used in cases where a deep and high-leveled learning of the material is needed. Mesrabadi, Fathi'azar, and Ostovar (2005) in a research titled "The Effectiveness of Presenting and Constructing Concept Maps Individually and in Groups as an Instruction Strategy" compared the effectiveness of presenting ready-made concept maps with those prepared by the learners, and also the effectiveness of constructing concept maps individually or in groups. The results showed an increase in the means of the subject groups in posttests compared with those in pretests. However, the highest amount of influence was in the construction method of concept maps, and the lowest in presenting concept maps.

Researches by Linda and Susan (2003) and Daley, Shaw, Glasenapp, and Piacentinein (1999) concerning "the effect of concept maps on critical thinking" show that concept maps are effective in helping students enhance their critical thinking skills.

Despite research documents that indicate the superiority of using concept maps over the current instruction methods, no influential step has

been taken in our education system to apply this strategy. In a research, Novak (1990) studied learning patterns of students in Cornell University, and concluded that most of the students don't spend the main part of their time on meaningful learning (Ekbacola and Jagged, Ruth, cited in Mesrabadi et al, 2005, p.15). In Novak's view, the change in schools' activities is very slow.

Therefore, our instruction methods need changes so that they pave the way for the growth of information processing in the minds of students, the reinforcement of cognition, critical-logical thinking skills, problem solving, decision-making, judgment, and arbitration while learning. Education makes sense if it can make students' innate talents flourish, and an instruction that attends to the memorization of facts and data cannot be called education (Behrangi and Aqayari, 2004).

It seems, therefore, that regarding the vast body of information at hand and the inefficiency of the traditional system of education in preparing the students professionally, it is necessary to change over the role of educational institutions from stores of information and the role of instructors from mere lecturers. Students, too, need to increase their mastery in thinking and reasoning, process the given data, and make use of them, instead of solely acquiring and memorizing information (Khalili, et al, 2003, p. 55). In this regard, the present research attends to the question of using the concept map method in teaching one of the baccalaureate courses to teacher trainees, and studies its effect on critical thinking, learning, and retention compared with the current method. Therefore, the following hypotheses are propounded:

**1.** There is a significant difference statistically in the degree of critical thinking between the students in the two groups, instructed through concept mapping and the current method.

**2.** There is a significant difference statistically in the degree of learning between the students in the two groups, instructed through concept mapping and the current method.

**3.** There is a significant difference statistically in the degree of retention between the students in the two groups, instructed through concept mapping and the current method.

## Methods

The present research was of the quasi-experimental type, done in the pretest-posttest plan along with an intact group. The research population consisted of 700 students at B. A. level in Shahid Beheshti Training College in Gonbad Kavus, Iran. The statistical sampling was done in the stratified random clusters method, and 40 students were selected. The subjects had been placed in the experimental and intact groups beforehand. Two devices were used in this research:

- The Critical Thinking Questionnaire. In order to assess the degree of critical thinking, the standardized Californian Test was applied. This questionnaire consists of 30 statements each of which is evaluated with five options (strongly agree, agree, no opinion, disagree, strongly disagree). In the present research, the reliability of this device was 0.78, which was calculated through retesting based on Cronbach's alpha coefficient of internal consistency. This is a relatively high and acceptable reliability.
- The Achievement Test. A test was used to gather the necessary data to examine the students' course achievement. It was a teacher-made test, and was given in the pretest-posttest format. The questions were written according to the syllabus for the course "Principles of Education". They were examined by three instructors of the training college who were experts in this field, and its content validity was confirmed. Since the questions were objective, the criterion for the test reliability was determined to be the raters' agreement.

For descriptive analysis of the data, statistical indicators such as the mean, variance, and standard deviation were used. For inferential analysis, the t-test and covariance analysis were applied. The research hypotheses were then confirmed or rejected by the SPSS software.

## Results

Hypothesis 1. There is a significant difference statistically in the degree of critical thinking between the students in the two groups, instructed through concept mapping and the current method. The results of descriptive data for critical thinking scores in Table 1 show the superiority of the experimental group trained through concept mapping with a mean of 4.41.

**Table 1**

Comparison of means of scores for the critical thinking posttest in the assesse groups.

| Sample groups | Sample size | Mean |
|---|---|---|
| Experimental group | 20 | 4.14 |
| Control group | 20 | 3.92 |

Considering the results in Table 2 using the t-test to compare the means of two separate groups, and by comparing these data with the acceptable probability level of 0.05 and 95 percent of certainty, the null hypothesis is rejected. It means that at the end of the research there is a significant statistical difference in the posttest between the degree of critical thinking in the two experimental and control groups after applying the variable (different teaching methods). This difference shows the superiority of the concept maps method over the current method. Therefore, we can claim that the independent variable of concept maps has been more effective on the degree of critical thinking in the students of the population under study than the current method. (df=21.48, t=9.046, sig=0.000).

**Table 2**

The statistics of critical thinking posttest in the assessed groups.

| The t-test for equivalence of means | | | The lvn-test for equivalence of variances | | |
|---|---|---|---|---|---|
| Mean differences | Level of significance | Degree of freedom | Amount of *t* | Level of significance | Amount of F |
| 0.328 | 0.000 | 21.48 | 9.046 | 0.001 | 13.371 |

In addition, the results for covariance test with the pretest control (Table 3) show that the significant effectiveness of the kind of teaching method is confirmed (sig= 0.000, F=100.321). Considering the eta coefficient, we can say that the kind of teaching method, after adjusting the effect of previous knowledge, signifies 73 percent of the posttest score variance.

**Table 3**
Results of covariance analysis of critical thinking posttest scores in two groups with previous knowledge controlled.

| Source of change | Sum of squares | Degree of freedom | Average of squares | F | sig | Effectiveness coefficient |
|---|---|---|---|---|---|---|
| Corrected model | 2.342 | 2 | 1.171 | 130.824 | 0.000 | 0.876 |
| Constant | 0.28 | 1 | 0.28 | 31.333 | 0.000 | 0.459 |
| Pretest | 1.828 | 1 | 1.828 | 204.251 | 0.000 | 0.847 |
| Group | 0.898 | 1 | 0.898 | 100.321 | 0.000 | 0.731 |
| Error | 0.331 | 37 | 0.009 | | | |
| Total | 2.673 | 40 | | | | |

Hypothesis 2. There is a significant difference statistically in the degree of learning between the students in the two groups, instructed through concept mapping and the current method. The results of descriptive data for learning scores in Table 4. show the superiority of the experimental group instructed through concept mapping with a mean of 13.40.

**Table 4**
Comparison of means of scores for learning posttest in the assessed groups.

| Sample groups | Sample size | Mean |
|---|---|---|
| Experimental group | 20 | 13.40 |
| Control group | 20 | 11.05 |

Considering the results in Table 5 using the t-test to compare the means of two separate groups, and by comparing these data with the acceptable probability level of 0.05 and 95 percent of certainty, the null hypothesis is rejected. It means that at the end of the research there is a significant statistical difference in the posttest between the degree of learning in the two experimental and control groups after applying the variable (different teaching methods). This difference shows the superiority of the concept maps method over the current method. Therefore, we can claim that the independent variable of concept maps has been more effective on the degree of learning in the students of the population under study than the current method (df=38, t=4.288, sig=0.000).

**Table 5**
The statistics of learning posttest in the assessed groups

| **The t-test for equivalence of means** | | | **The lvn-test for equivalence of variances** | | |
|---|---|---|---|---|---|
| Mean differences | Level of significance | Degree of freedom | Amount of *t* | Level of significance | Amount of F |
| 2.15 | 0.000 | 38 | 4.288 | 0.172 | 1.933 |

In addition, the results for covariance test with the pretest control (Table 6) show that the significant effectiveness of the kind of teaching method is confirmed (sig= 0.000, F=35.106). Considering the eta coefficient, we can say that the kind of teaching method, after adjusting the effect of previous knowledge, signifies 49 percent of the posttest score variance.

**Table 6**
Results of covariance analysis of learning posttest scores in two groups with previous knowledge controlled.

| **Source of change** | **Sum of squares** | **Degree of freedom** | **Average of squares** | **F** | **sig** | **Effectiveness coefficient** |
|---|---|---|---|---|---|---|
| Corrected model | 239.567 | 2 | 119.783 | 88.272 | 0.000 | 0.827 |
| Constant | 191.352 | 1 | 191.352 | 141.014 | 0.000 | 0.792 |
| Pretest | 188.942 | 1 | 188.942 | 139.238 | 0.000 | 0.790 |
| Group | 47.638 | 1 | 47.638 | 35.106 | 0.000 | 0.487 |
| Error | 50.208 | 37 | 1.357 | | | |
| Total | 6219 | 40 | | | | |

Hypothesis 3. There is a significant difference statistically in the degree of retention between the students in the two groups, instructed through concept mapping and the current method.

The results of descriptive data for retention scores in Table 7. show the superiority of the experimental group instructed through concept mapping with a mean of 12.45. Considering the results in Table 8 using the t-test to compare the means of two separate groups, and by comparing these data with the acceptable probability level of 0.05 and 95 percent of certainty, the null hypothesis is rejected. It means that at the end of the research there is a significant statistical difference in the posttest between the degree of retention in the two experimental and control groups after applying the variable (different teaching methods).

**Table 7**
Comparison of means of scores for retention posttest in the assessed groups.

| Sample groups | Sample size | Mean |
|---|---|---|
| Experimental group | 20 | 12.45 |
| Control group | 20 | 9.6 |

This difference shows the superiority of the concept maps method over the current method. Therefore, we can claim that the independent variable of concept maps has been more effective on the degree of retention in the students of the population under study than the current method (df=38, t=4.06, sig=0.000).

**Table 8**
The statistics of retention posttest in the assessed groups.

| The t-test for equivalence of means | | | The lvn- test for equivalence of variances | | |
|---|---|---|---|---|---|
| Mean differences | Level of significance | Degree of freedom | Amount of *t* | Level of significance | Amount of F |
| 2.75 | 0.000 | 38 | 4.06 | 0.359 | 0.862 |

In addition, the results for covariance test with the pretest control (Table 9) show that the significant effectiveness of the kind of teaching method is confirmed (sig= 0.000, F=52.111). Considering the eta coefficient, we can say that the kind of teaching method, after adjusting the effect of previous knowledge, signifies 59 percent of the posttest score variance..

**Table 9**
Results of covariance analysis of retention test scores in two groups with previous knowledge controlled

| Source of change | Sum of squares | Degree of freedom | Average of squares | F | sig | Effectiveness coefficient |
|---|---|---|---|---|---|---|
| Corrected model | 173.197 | 2 | 86.598 | 57.444 | 0.000 | 0.756 |
| Constant | 231.219 | 1 | 231.219 | 153.377 | 0.000 | 0.806 |
| Pretest | 91.972 | 1 | 91.927 | 61.009 | 0.000 | 0.622 |
| Group | 78.56 | 1 | 78.559 | 52.111 | 0.000 | 0.585 |
| Error | 55.778 | 37 | 1.508 | | | |
| Total | 5091 | 40 | | | | |

**Discussion and Conclusion**

The research findings show that there is a significant difference in the degree of critical thinking between the students in the two groups, instructed through concept mapping and the current method. Research findings are in accordance with research results of Hosseini (2009), Linda and Susan (2003), and Daley, et al (1999). To explain the obtained results we can say that teaching through the concept maps method is effective in helping students enhance their critical thinking skills. Results showed that there is a significant difference in the degree of learning between the students in the two groups, instructed through concept mapping and the current method. Research findings are in accordance with research results of Rahmani, et al (2007), Mesrabadi and Ostovar (2009), Mesrabadi, Fathi'azar, and Ostovar (2005), Abbasi, Mirza'i, and Hatami (2008), Mesrabadi, Hosseini Nasab, Fathi'azar, and Moqaddam (2007), Sarhangi, et al (2010), Qanbari, Paryad, and Ehsani (2010), Nejat, Kuhestani, and Reza'i (2011), Tseng, et al (2011), and Liu, et al (2010). Results showed that there is a significant difference in the degree of retention between the students in the two groups, instructed through concept mapping and the current method. Research findings are in accordance with research results of Mesrabadi, Hosseini Nasab, Fathi'azar, and Moqaddam (2009), Sarhangi, et al (2010), Qanbari, Paryad, and Ehsani (2010), and Tseng, et al (2011). To explain the obtained results we can say that since this model is backed by strong theory and makes use of many important learning theories in the field of educational psychology, it can be attended to as a suitable model in teaching different subjects. This model can be effective in learning and permanent retention of materials because it involves the visual sense of students, which, according to numerous researches, constitutes about 75 to 80 percent of human learning.

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