The Effectiveness of Teaching Through Concept Maps on Critical Thinking and Academic Self-Concept

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Abstract

The purpose of this study was the effectiveness of teaching through concept maps on critical thinking and academic self-concept. The research method is quasi-experimental with a pre-test - post-test design with a control group. The statistical population included all high school male students in Marvdasht in the academic year 2020-2021. The sample size was selected using step wise cluster random sampling. And the selected individuals were placed in two groups; experimental group (30 people) and control group (30 people). The Data collection tools in this study were Ricketts critical thinking and Rogers academic self-concept questionnaires, which confirmed the validity and reliability of the instrument. Data were analyzed using descriptive and inferential statistics. At the level of descriptive statistics; Frequency, mean and standard deviation and at the level of inferential statistics, uni-variate analysis of covariance test were used. The results showed that teaching through concept maps has a significant effect on students; critical thinking. Teaching by conceptual maps has a significant effect on academic self-concept. The use of active and effective teaching methods, including the concept map method, can promote critical thinking and academic self-concept in students. Concept maps make it possible to deepen the process of teaching and learning to reach higher levels of cognition and a variety of abstract, creative and critical thinking.

Key Words: Concept Maps, Critical Thinking, Academic Self-Concept, Students.

Introduction

The interest in developing intellectual abilities is not a phenomenon that has been considered in the present age; Such interest is rooted in the history of education (Shabani, 1396). Basically, thinking and thought is the beginning of any production and construction in the human world. May be it is because of the historical path of philosophical thought in either West or east, this human capability and its direct product, namely knowledge has been paid so much attention (Rashno, 2011).

Critical thinking is a competence that is needed and required by students in their personal and professional lives. For this reason, the education system and schools must make every effort to include it in their curricula, programs and classes (Bezanilla, Fernandez, Poblett, Galindo Dominguez, 2019).

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Critical thinking is defined as conscious thinking planned for new ideas, possible with reason that uses high-level cognitive skills such as conceptualization, analysis, and evaluation to lead to logical and appropriate action (Koo), Kong, Song, Deng and Kang, 2019).

The mission and one of the main goals of education is to produce people who can think and not be satisfied with the product of others' thought. Training people with critical thinking who want to research, not just those who accept what is being said. Experts have considered the main goal of teachers and students' education to be the development of critical thinking skills (Edwards, 2007; quoted by Etemadi, 1398). Accordingly, paying attention to critical thinking in students seems to be important and necessary.

On the other hand, students' beliefs and perceptions about the importance and position of learning, knowledge and awareness of their ability and skill in performing homework and activities related to school, and emotional feelings and reactions to such activities can help students increase their motivate in learning. These beliefs and perceptions are called self-concept. Self-concept is a comprehensive view of oneself in the set of different domains as well as one's perceptions based on one’s knowledge of himself. This structure also includes individual evaluations of the values obtained through personal experiences with the environment (Shiulsson, Hobner, and Stanton, quoted in Abuii, 2019). Self-concept also refers to a network of positive and negative beliefs about accepting or rejecting oneself (Ahmad and Bravinsma, 2006).

Academic self-concept expresses individual knowledge and perceptions about their strengths and weaknesses in a given field of study and individual beliefs about their ability to successfully perform homework at designed levels. It is one of the most important and effective factors in the learning process. Be (Karim Lu, 1395).

Academic self-concept relies heavily on relative social information and is reflection of others' evaluations It is of a normative nature; In other words, each person's academic self-concept is achieved as a result of his / her comparison with others (Pajras and Shank, 2001). Academic self-concept has been associated with many academic factors and outcomes, including student interaction and motivation, emotion, academic adjustment, well-being, academic achievement, or school performance (Van der Rey, Peters, Van in Kreissen, and Crohn's, 2019).

The most important characteristic of academic self-concept is the state that defines one&# 39;s self-concept as a result of interactions and experiences with others and confirms the fact that academic self-concept is learnable and achievable over time. Teachers play an important role in forming self-concept specially in academic self-concept (Mandaglio and Pirt,

2003). In the teaching-learning process, positive attitude of students towards their abilities can play a very important role in the quality of their educational activities. Most students who do not make good progress and are constantly experiencing academic failure have a negative and limiting mental image of their academic talents and learning abilities. It is due to the generalization of their previous experiences and the way through which they have been trained and educated at different stages of their lives. Students who do not feel good about their ability, even regardless of race and skin color, are rarely successful in their academic activities (Mikaeli, Afrooz and Gholi Zadeh, 2012).

Nowadays, there have been various educational programs and methods to increase critical thinking and academic self-concept. It seems that one of these educational programs is the use of a concept map for teaching science.

The purpose of teaching with concept maps is to put the concepts in the students' minds so that they can better relate these concepts to the concepts that already exist in their mind. If the student can apply the concepts he has learned with different conditions and then adapt them to new conditions, concept maps are considered one of the most effective teaching methods (Turan and Akmaxi, 2018).

In confirmation of this, we can refer to the research of Kalhor and Mehran (2017) which is entitled the effect of group construction of a concept map on students' critical thinking skills. The purpose of this study was to investigate the effect of concept mapping on critical thinking skillsin students. The sample included 50 third grade of high school female students in Karaj city that were selected through purposive sampling. The research project was a quasi experimental design of pre- test and post-test with control group. The subjects were randomly assigned to experimental and control group. The experimental group was through using concept mapping cooperatively, while control group was not exposed to such kind of learning technique and the students in this group were through in common way of reading comprehension teaching.The California Critical Thinking Skills Test form B (CCTST) was used to measure the critical thinking ability of the students. The data were analyzed with Analysis of covariancetest (ANCOVA), and showed that the students in the experimental group achieved significantly higher critical thinking scores than the students in the control group. The findings reveal that using concept mapping as a learning strategy is effective in helping students develop critical thinking skills. Karami and Babamoradi (2017) conducted a study on the effect of concept map teaching method on students' self-regulation and academic self-concept . Analysis of covariance showed that the use of Concept mapping teaching method is effective on self-regulation and academic self-concept. Thus,

according to effectiveness of Concept mapping teaching method in a significant learning and Its effectiveness on key variables such as self-regulation and Academic Self-concept in the field of education, it should be used as one of the important mission in education.

Vahedi, Malekzadeh and Piri (2015) A study was conducted to determine The effectiveness of concept maps in teaching mathematics concepts and mathematics self-concept among elementary school students. The study examined the effect of concept-mapping on mathematical problem- solving performance and self-concept among 5th graders elementary school students. A pretest and posttest control-group quasi-experimental design was employed to evaluate the instructional effectiveness of this strategy. Thirty boys were randomly selected from two elementary schools located in Bostanabad District of Tabriz city, Iran was used as subjects for the study. One classroom of 15 fifth-grade students made up the experimental group, and 15 fifth-grade classrooms students comprised the control group. The experimental group was taught selected topics in math using concept-mapping strategies, while the control group was taught using the traditional lecture method. The Self-Description Questionnaires (SDQ) and mathematical performance test were used for data collection. Data have been analyzed by ANCOVA and T-test. The result of the study showed that the experimental group performed significantly better in mathematical problem solving than the control group. Also, the findings revealed that the concept mapping promotes students' mathematics self-concept.

Growood, Ahmed and Mc Camp (2018) conducted a study entitled The Effect of Concept Maps on Undergraduate Nursing Students' Critical Thinking. A literature review was conducted using "concept maps, nursing education, and critical thinking" as the combined search terms. Inclusion criteria were studies that measured the effects of concept mapping on critical thinking in nursing students. Seventeen articles were identified. Concept maps may be useful tools to promote critical thinking in nursing education and for applying theory to practice.

Concept maps in education provide a comprehensive and clear picture of different concepts and their relationship in a small space and at the same time, one can easily focus on any part of it. It is much faster and more practical to review concepts in this way than non-drawing summaries. Therefore, concept maps are effective both in teaching and in learning concepts (Samiei Zafarghandi, 2014). All these cases show the effectiveness of this method in science education,and accordingly make it necessary to be used.

Based on what has been said, the researches that have been done in the field of concept maps is very limited, so the research gap is quite obvious. Therefore, more extensive

researches are needed to get conclusion on the effectiveness of the concept map method in critical thinking and academic self-concept.

Effective steps can be taken to apply this learning method in the classroom since many research findings, theories and experimental studies consider concept map as an effective method. Therefore, using concept maps can improve scope of critical thinking and the academic self-concept, avoid wasting financial resources and consequently prevent the disappearance of students' talents and ultimately lead to scientific growth in the country. This research will pave the way for further researches in the field of education and student learning. The present study seeks to address the existing research shortcomings by answering the following question & quot; Is the effectiveness of concept maps education is effective on critical thinking and academic self-concept of high school students in Marvdasht?

Research methodology

The general design of this study according to the objectives and nature of the research is a quasi-experimental one with pre-test and post-test along with the control group. After selecting the sample group and randomly placing them as experimental and control groups, both groups were tested at the same time (Critical Thinking Scale, Academic Self-Concept Scale). After that, concept map training was performed for 6 sessions to the experimental group. A week later, to compare this intervention, post-test was taken from both groups. pre-test and post-test results in both groups were compared with each other.

The experimental design diagram is as follows:

Post-test	Independent Variables	Pre-test	Group
T2	X	T1	Experimental R
T2	--	T1	Control R

The statistical population included all male high school students in Marvdasht. in the academic year 1399-1399. In order to select the sample group, multi-stage cluster random sampling method was used. Four schools were randomly selected from the secondary school boys and then 1 class was selected in the next stage from each school. A total number of 100 students were placed in both experimental (n = 50) and control (n = 50) groups.

Ricketts critical thinking test was used to assess the level of students' critical thinking. The Critical Thinking Tendency Questionnaire (Ricketts, 2003) is a self-report tool that measures the tendency to critical thinking. The scientific reliability of this test was calculated (0.70-0.68) using Richardson's Koder test. In Iran, the validity, reliability and norm of this test have been confirmed. The validity, reliability and standardization of this test in Iran have been studied by Khalili and Soleimani. The reliability coefficient of the test was

calculated to be 0.62 using Richardson's 20-code formula. In a methodological study, the face and content validity of the test was confirmed. The reliability of this test was obtained using Richardson&# 39;s Koder formula. To be sure, in this study, the reliability rate was calculated through Cronbach&# 39;s alpha method and the rate was 0.91.

Rogers questionnaire was also used to assess academic self-concept. The reliability coefficient of this test was obtained by using the bisection method of 0.80 (Mousavi, 2008). Its validity was confirmed by content professors by three professors of counseling and psychology (same). In general, the validity coefficient of Rogers self-concept questionnaire in research has ranged from 0.82 to 0.89. To be sure, in this study, the reliability rate was calculated through Cronbach's alpha method and the rate was 0.89.

How to implement the intervention

To Explain how to implement the intervention, it should be said that after identifying the control and experimental groups and before conducting the research, all subjects were introduced to the objectives of the research in one session and students were allowed to ask about the educational topic. Then, pre-tests were taken from both groups. From the second session, the members of the two groups were trained in the conceptual training method and the conventional method (without using the concept map). In such situations, concept maps in different parts of education were used as a way of presenting content. Before the start of the training, a concept map poster of the new lesson was installed in front of the students as pre-organizer, during the training, it was used as content presenter and after training as a content summarizing tool. At the end of the lesson, the teacher, as homework, asks the students to draw the concept map of the taught lesson in their notebooks and present it in the next session. The students were taught how to draw maps by the instructor. In the sessions where the students handed over the prepared works, their works were reviewed and their possible problems and misunderstandings were eliminated as much as possible. Finally, after the sessions, post-test was performed to both groups.

Table 1- Mean and standard deviation of variables of critical thinking and academic self-concept in experimental and control groups in pre-test, post-test

		Experimental group			Control group		
Variables	Test	Mean	Standard Deviation	number	Mean	Standard Deviation	Number
Critical Thinking	Pre-test	3.45	0.3	30	3.67	0.4	30
	Post-test	3.96	0.4	30	3.66	0.5	30

Academic self-concepts	Pre-test	2.62	0.30	30	2.28	0.28	30
	Post-test	2.67	0.09	30	2.38	0.11	30

Research Findings

As can be seen in Table 1, in the experimental group at the post-test stage (after training by concept maps), the average of critical thinking and academic self-concept has increased, while this difference is not significant in the control group.

Hypothesis 1: Concept map teaching is effective on students' critical thinking.

Default one: normal distribution of scores

The first method to check the normality of the scores distribution;

Table 2- Assessing the normality of critical thinking scores by the of skew and height method.

Critical thinking	number	skew		height	
	statistics	statistics	Deviation error	statistics	Deviation error
Pre-test	120	-0.554	0.221	1.108	0.438
Post-test	120	-0.555	0.221	0.631	0.438

Since the amount of skewness and elongation for the variable is in the range (2 ±̊20º), then the distribution is probably normal.

The second method to check the normality of the distribution of scores:

Table 3- Assessing the normality of the critical thinking variable by Kolmogorov-Smirnov test

Variable	Kolmogorov-Smirnov test		
	number	ststistics	Significance level
Pre-test	120	1.139	0.1
Post-test	120	0.677	0.7

According to the above table, it can be seen that the significant levels are higher than the acceptable value (0.05), so the normality tests of this variable are not significant. Therefore, the hypothesis of normality is confirmed. (05 / 0P-Value.<

The second default: checking the homogeneity of variances

Table 4- Determining the variance parity of critical thinking scores (Levin test)

Variable	Test	F value	The first degree of freedom	The second degree of freedom	Significance Level(p)

Critical thinking	Pre-test	2.791	1	118	0.09
	Post-test	1.962	1	118	0.1

As can be seen from Table 4, the values of /f/ in the pre-test and post-test of critical thinking were not significant (p <0.05), so we conclude that there is no significant difference between the variance of the scores of the experimental and control groups in the pre-test and post-test.

Table 5 - interaction test between the group and pre-test by following the general critical thinking variable

Variable	changes source	squares sum	Freedom level	square average	Test statistics	Significance level
Critical thinking	The effect of pre-test and group interaction	6132.925	2	3066.462	12.4	0.0001

Assumption 3: Investigating the homogeneity of the regression slope

According to Table 5, it can be seen that the value of f of the pretest-group interaction is equal to 12.4, which is significant (P <0.01), so it can be concluded that the assumption of homogeneity of regression slope is not observed.

Now, considering these three presuppositions and non-observance of the presupposition of regression slope homogeneity, the method of "covariance analysis" can not be used for statistical analysis of the effect of teaching concept maps method on students' critical thinking. the analysis of variance test is used as a factor on score differences between post-test and pre-test scores. The results are seen in the above tables.

Table 6 - Investigating the differences in the scores of the critical thinking component between experimental and control groups

Group	Number	Median differences	Standard deviation
Experimental	30	-13.88	20.4
Control	30	0.2333	14.1

Table 7- Evaluation of one-way variance analysis of critical thinking scores between experimental and control groups

Changes source	squares sum	Freedom level	Squares mean	F	P
Inter group	5978.408	1	5978.408	19.3	0.0001
Intra group	3642.917	118	308.567		
Sum	42389.325	119			

According to Table 7 and observing the level of significance, it can be seen that the value of test statistics (19.3) at the level (0.0001) has become significant ($p < 0.01$) (because it is less than the acceptable level of 0.05). This means that there is a significant difference between the critical thinking scores of the students in the experimental group compared to the control group. And from the difference between the means in Table 6, it can be concluded that teaching the concept map method has a significant effect on the students' critical thinking in the experimental group.

Hypothesis 2: Concept map education has a significant effect on students' academic self-concept

• Examining the assumptions of analysis of covariance:

Default normal distribution of scores.

Table 8- Checking the normality of the academic self-concept variable

Variable	Kolmogorov-Smirnov test		
	number	statistics	Significance Level
Pre-test academic self-concept	30	0,81	0.5
Post-test academic self-concept	30	0.98	0.2

The results of the analysis of the above table show that the value of significant levels in the above test is greater than 0.05. Null hypothesis in the Kolmogorov-Smirnov test states that the data follow the desired distribution (which is normal here). The opposite hypothesis is that the data does not follow the desired distribution (which is normal here), according to the value of significant levels, the null hypothesis is not rejected, so the data distribution is considered consistent with the normal distribution.

2)Homogeneity of variance: The subjects should be homogeneous in terms of variance. The Levin test checks this assumption.

Table 9 - Determining the equality of variance of academic self-concept scores (Levin test)

Variable	F	First freedom level	Second freedom level	Significance level (P)
Pre-test academic self concept	3.3	1	118	0.07
post-test academic self concept	0.69	1	118	0.4

As can be seen from the table above, the value of f was not significant for the pre-test and post-test academic self-concept variables ($p < 0.05$), so we conclude that between the variance of the experimental and control group scores in the post-test, There is no significant difference between the variables, so this assumption has been observed. Therefore, according to the obtained results, the analysis of covariance is used to analyze this hypothesis.

Table 10 - Investigating the difference between the scores of the academic self-concept post-test

Changes source	Squres Sum	Freedom level	Squares mean	F	Significance level	Eta coefficient
Pre-test effect	13.11	1	13.11	0.149	0.7	0.001
Independent Variable effect	31660.884	1	31660.884	358.8	0.0001	0.75
error	10322.051	117	88.223	------	-------	----
				-		
Total adjusted	777116.00	120	-------	------	--------	-------
				--		

As can be seen in the second row, the value of f is equal to (358.8), which is significant at the level (0.0001) (because it is less than the acceptable level of 0.05), so we conclude that There is a significant difference between the scores of academic self-concept in the post-test after eliminating the effect of the pre-test. Therefore, this hypothesis is confirmed, ie education through concept maps has had an effect on increasing students' academic self-concept. and the effect of this education on academic self-concept (ETA coefficient) is 75%, ie 75% of the total variance or individual differences in academic self-concept is related to the difference between the two groups and 25% is related to other unknown factors. In other words, the variable by the method of concept maps has caused individual differences in academic self-concept to increase by 25%.

Discussion

The aim of this study is to find out the effectiveness of concept maps method on critical thinking and academic self-concept of second grade high school students in Marvdasht. Findings showed that concept map training has a significant effect on students' critical thinking and the research hypothesis is confirmed. This part of the findings is consistent with the results of the researches by Habibzadeh and Rasouli (2013), Kalhor and Mehran (2017) and Growwood, Ahmad and McCamp (2018). In explaining these findings, Concept map facilitates meaningful and in-depth learning by providing a model and framework for organizing knowledge, and by representing a specific perception of a field of knowledge, organizing and constructing a hierarchy of concepts, identifying learners' misconceptions and knowledge gaps, a framework for analyzing Provides composition and evaluation, which are important elements of critical thinking.

Calderón-Steck (2005) describes concept mapping as a very successful way to teach both the concepts necessary for critical analysis and the skills needed to learn how to learn.

It should be mentioned that perhaps one of the factors that led to the superiority of concept map of teaching to the usual method is that students' learning here is not parrot-like, so that students try to use this method to combine new information with concepts in their previous cognitive structure and consequently they achieve a full understanding of the content. In this method, the student also actively participates in learning and manipulates various concepts and information and explain new information according to previous knowledge; That is, they consciously places information in its cognitive structure. These processes allow learners to exchange views on the relevance of concepts, to discuss the correctness of propositions, to discover hidden connections, how the map is structured, and to reconstruct it. Thus, the skills of analysis, comparison, evaluation and composition, which are the basis of critical thinking are strengthened. Because students have an important role in the life of every generation in society, and without their growth and education, the development of human society is not possible. Therefore, educators should strive to strengthen students' talents, increase their intellectual abilities, and develop new ways to achieve this goal. For effective measurements of educational thinking, there is a need to change the quality and quantity of students -students, and student- teacher discussion in the classroom.

The findings also showed that there is a significant difference between the academic self-concept of the experimental and control groups in the post-test stage, in other words, teaching science through the concept map method has a significant effect on students' academic self-

concept. This part of the findings is consistent with the researches results of Karami and Babamoradi (1396) Vahedi, Malekzadeh and Piri (1397).

Students are able to gain a deeper understanding of the educational content by using concept maps and by making better use of analysis in the context raised in the classroom. They feel that they have mastered information. According to the research results on the effect of concept maps education on students' critical thinking; it is suggested that educational workshops be held to acquaint teachers with the general principles of the concept map approach to provide areas for its application and then use it in the current education process. Since the effectiveness of the concept map approach on academic self-concept has been confirmed in many experimental studies as well as the present study, so this method is better to be as one of the effective ways by teachers to improve students' academic self-concept and also be an effective alternative to traditional learning methods. It is suggested to future researchers to do the same research among other academic levels (for example in universities) and compare this method with several other new teaching methods to possibly yield fruitful results.

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