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Effectiveness of Teaching through Brainstorming on the Students' Critical Thinking and Motivation

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A B S T R A C T

Among the most important goals of modern systems of education is teaching individuals to be able to easily overcome the issues and problems in daily life and in social settings. In this context, the students' motivation and critical thinking are the factors affecting the students' life and future. In this respect, the aim of this study is to evaluate the effectiveness of teaching through brainstorming on critical thinking and academic motivation of boy students in fifth grade of elementary school in Bandar Abbas. The study is a semi-experimental study and pretest - posttest with control group is applied. The study population consists of all students in fifth grade at District 1 of Bandar Abbas city. Using cluster sampling method, the sample, including 150 fifth grade students, is selected. The study instruments include Ricketts Critical Thinking Questionnaire and Valrand Academic Motivation Questionnaire. Intervention sessions are run for ten 60-minute sessions for students. After data collection and to control the effect of pre-test on the post-test, covariance analysis and multivariate variance analysis are used and the results are analyzed by SPSS statistical software. Research findings indicate a significant difference between critical thinking scores (Sig. < 0.001) and academic motivation (Sig. < 0.001) in the experimental group. In other words, teaching through brainstorming impacts on critical thinking and motivation of elementary school students in fifth grade.

Keywords: Students, Brainstorming, Critical Thinking, Academic Motivation.

INTRODUCTION

Students should improve their creative and critical thinking skills to make good decisions and solve complex problems of society to cope with amazing developments in the third millennium. They must enhance their research skills, problem solving and search morale. It is clear that to achieve these goals, a heavy responsibility is on the shoulders of educational institutions, especially education. These centers on the one hand, are responsible for teaching and equipping the students with their required information. On the other hand, they must provide

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the situation, which help develop and foster innovative and proper and directional use of talents and abilities¹.

One of the fundamental characteristics of human is consciousness about his behavior and having thinking force. In other words, one can be aware of his/her behavior and use his/her thinking force in dealing with different issues and affairs². Interest in intellectual skills is a phenomenon that is rooted in the history of education. However, unfortunately, educational institutions by ignoring this principle, have turned their attention to transferring data and scientific facts³. However, in the face of new issues, the use of stereotypical thoughts stereotypical thoughts and conventional and traditional methods is not useful⁴. Therefore, the emphasis on active teaching methods should be a priority in educational systems to facilitate the students' talents and characteristics flaunting.

Among active teaching techniques such as problem solving, brainstorming, pre-arranged pattern, heuristics, brainstorming method is one of the most popular active teaching methods. This method was introduced in the early 1930s by Alex Osborn. He defines the term brainstorming as: a collective technique, in which a group tries to find a solution to a specific problem by gathering all ideas the members of the group spontaneously contribute⁵. The main purpose of the brainstorming method is that the process of producing the answers is separate from the process of evaluating them. Since, the evaluation often suppresses the production of a variety of responses and hinders creativity. Brainstorming method is one of the most effective methods in promoting creativity and critical thinking of students. Many researchers have confirmed the relationship between creativity and critical thinking and have stated that brainstorming method affects these two components ^{6, 7, 8, 9, 10, 11}.

Critical thinking is a metacognitive strategy and a complex skill, which needs great mind processes and judgment based on the evidence. Accordingly, identification and articulation of issues, observation and judgment about an issue, data collection, organization and analysis of information and conclusion, all are the activities that occur in critical thinking ^{12, 13}.

Students, who have developed critical thinking and apply it, are able to think independently, recognize the limits of their knowledge, understand the subjects with more depth, more long-lasting and even at more useful level and obtain higher results and scores of quizzes. These factors in turn will lead to improved academic performance ^{12, 14}.

In addition, one of the success factors that should pay special attention to it, regard to the knowledge seekers and students, is academic motivation. In the complex age of information and communications that human knowledge changes for the second, more productivity belongs to those environments that develop and

encourage the ability to think independently and cooperatively. This refers to critical and self-directed learners who have enough ability and motivation to meditate and participate and enjoy enough motivation to continue learning throughout the life ¹⁵.

Motivation is the most important prerequisite for learning. Motivation is the heart of learning. Motivation is the human movement incentive and trigger, guidance, advantageous and behavior stabilizer until the desired goal is achieved¹⁶. Psychologists have noted the necessity of considering motivation in education, because of its effective communication with new learning, skills, strategies and behaviors and one of the basic structures that they have provided to explain the motivation is academic achievement motivation ¹⁷.

Academic achievement motivation refers to behaviors that are conducive to learning and progress. Given the foregoing, the present study examines the effectiveness of teaching brainstorming on the students' critical thinking and academic motivation.

METHODOLOGY

Since this study aims to evaluate the effectiveness of teaching through brainstorming on critical thinking and academic motivation of fifth grade students, the study is based on a quasi-experimental and pretest - posttest with control group is used. The study sample includes all fifth grade male students in District 1 of Bandar Abbas, who had been studying in the academic year 2015-2016. According to the project design, and using Cochran formula, of a total of 255 subjects as the population, 150 subjects are considered as research sample. Therefore, the sample consists of 150 secondary school male students in Bandar Abbas. Among the total of fifth grade students, using cluster sampling, first of all schools in the District 1 of Bandar Abbas city, two schools, and of the two schools, 4 classes are selected. Then, two classes are selected as the experimental group, and two classes are selected as the control group. The following questionnaires are used for data collection.

Critical Thinking Inventory

The main form of the critical thinking test is made by Ricketts. The scale has 33 items and includes three subscales. The first part consists of 11 questions to assess the scale of creativity. The second part contains 9 questions about the scale of development and the third part consists of 13 questions to measure commitment that the subject answers it based on the 5-point scale. The test score is obtained from the sum of the achieved scores in 3 subscale. The interpretation of the scores is that, the score between 33 and 66 indicates poor critical thinking, the score between 66 and 99 represents average critical thinking and the score

above 99 indicates strong critical thinking. The reliability of the questionnaire by Cronbach's alpha coefficient for the total sample has been reported 0.94, for female subjects 0.95 and for male subjects 0.92.

Academic Motivation Inventory

This scale was made by Valrand et al to measure academic motivation based on self-determination theory of Ryan and Deci, which has six subscales, including knowledge motivation, performance motivation, excitation experience, external regulation, internal regulation and identical regulation. The questionnaire contains 28 items. The questionnaire responses are set on a seven-point Likert scale ranging from strongly disagree (0) to strongly agree ⁶. Bahrani ¹⁸ has evaluated the reliability of the test using test-retest method and Cronbach's alpha. In the retest method in the interval of two weeks, the coefficient of 0.73 was obtained. In addition, the alpha coefficient calculated for the entire questionnaire is equivalent to 0.88. Furthermore, the analysis of the academic motivation scale could demonstrate the three dimensions of internal motivation, external motivation and no motivation with especial value higher than one. Therefore, the reliability and validity are confirmed.

Introduction of an Intervention Program and its Implementation

In order to implement mathematics education through the method of brainstorming, a teaching package is designed based on the following steps:

1) First, some parts of the mathematics book are chosen to teach through brainstorming method, which consist of different parts, such as addition and subtraction of complex numbers, patterns, introducing billion, fractions larger than units, fractions multiply and divide, mixed numbers, percentage proportion, equal and symmetrical proportions.

2) In each session, a discussion is designed and delivered based on the principle of brainstorming, apart from the fifth and tenth sessions, which are hold to review taught concepts and establishment of brainstorming method.

3) Provision of brainstorming and grouping rules

* Teacher Activity

Installation of brainstorming rules on the class board that these rules are:

Criticizing the correct or wrong ideas of individuals is prohibited, because it slows the process of the activity and leads the individuals to criticism instead of thinking.

Judgment and evaluation about members' ideas and thought is prohibited at stages of brainstorming, because time is wasted and members' attention is attracted to the performance.

The quantity of ideas must be greater to have more creative ideas.

The members can change the views of other members, assimilate and integrate them and make a new idea.

Irrational and illogical as well as innovative and fresh ideas must be taken into account.

Ideas identification is free, because untapped and new ideas are obtained.

Grouping Students and Choosing the Leader and Secretaries

* Students Activity:

Considering the rules of brainstorming

Collaborating with the teacher and the group leader and secretary

Expression of Ideas

* Teacher activity:

Guiding students to express opinions and ideas

Participation in the groups and encouraging students to present more ideas

* Students Activity:

Expressing ideas and opinions on the topic presented

Obedying brainstorming rules

Submitting the ideas by secretary

Refining Ideas and Analyzing It

* Teacher activity:

- Calling on the leaders to classify the presented ideas and delete similar ideas
- Alerting the groups to avoid elimination of new and creative ideas
- Requesting leaders for presenting comments
- Identifying the ideas that need to be improved
- Commenting on the proposed ideas and analyze them

Students Activity:

- Classifying registered ideas
- Group agreed to delete inappropriate and similar ideas
- Participating in group discussion and commenting on the presented ideas
- Rating opinions regarding the importance

In this study, before running the program, the tests of Ricketts' critical thinking and Valrand's academic motivation are carried out, so that they are applied first in the experimental group and then in the control group in the same within one day. Two days after the tests performed, teaching brainstorming method is started and conducted over ten 60-minute sessions. After three days from the last teaching session, post-tests are applied in the two groups.

To review research data, analysis of covariance and multivariate analysis of variance are applied to assess the effectiveness of teaching through brainstorming on academic motivation and critical thinking between the two groups.

RESULTS

Research obtained descriptive results including scores of critical thinking and academic motivation separately associated with explanations are provided below.

Table 1. Descriptive Data Related to Critical Thinking

Variable	Groups	Pretest		Posttest	
		Mean	Std. Deviation	Mean	Std. Deviation
Creativity	Experimental	35.40	11.81	40.80	10.13
	Control	35.80	10.88	36.29	10.77
Development	Experimental	35.50	5.94	39.38	4.16
	Control	36.08	5.04	37.22	5.02
Commitment	Experimental	44.96	7.68	48.96	7.48
	Control	44.28	7.48	45.37	7.37
Critical Thinking	Experimental	115.86	18.48	129.14	15.77
	Control	116.16	16.73	118.89	16.20

As can be seen in the above table, the scores of the experimental group subjects in the variables in post-test are increased. In the inferential findings part, it is examined whether these changes obtained from the post-test of the research variables are statistically significant or not.

Table 2. Descriptive Data on Components of Academic Motivation

Variable	Groups	Pretest		Posttest	
		Mean	Std. Deviation	Mean	Std. Deviation
Knowledge Motivation	Experimental	15.36	3.95	18.88	4.11
	Control	14.30	3.53	14.92	3.38
Performance Motivation	Experimental	16.00	3.51	19.88	3.59
	Control	16.82	3.07	17.49	3.08
Excitation Experience	Experimental	15.93	3.12	19.42	3.54
	Control	16.24	3.45	16.62	3.91
Identical Regulation	Experimental	17.14	2.81	18.76	2.60
	Control	16.70	2.78	17.21	2.90
Introjected Regulation	Experimental	12.82	2.40	14.94	2.82
	Control	13.68	3.29	14.89	2.93
External Regulation	Experimental	15.09	4.94	13.35	3.61
	Control	16.10	4.20	15.99	4.27
Lack of Motivation	Experimental	13.94	3.99	11.05	3.57
	Control	13.45	4.40	14.17	3.91
Academic Motivation (Total)	Experimental	106.33	11.67	124.63	10.86
	Control	107.36	9.72	113.29	9.17

As can be seen in the above table, the scores of the experimental group subjects in the variables in post-test are increased. In the Table 6, it is examined whether these changes obtained from the post-test of the research variables are statistically significant or not.

Table 3. Summary of Linearity of Pre-test and Post-test of Critical Thinking and its Components

Resources	F	P
Commitment	10.75	0.001
Creativity	3.79	0.03
Development	15.76	0.001
Critical Thinking	11.73	0.001

As shown in Table 3, in connection with the critical thinking and all its components, regard to the significant level obtained (Sig.< 0.05), there is a linear relationship between the components in the experimental and control groups and the assumption of linearity for components is confirmed.

Table 4. Summary of Linearity of Pre-test and Post-test of Academic Motivation and its Components

Resource	F	P
Academic Motivation	12.22	0.001
Knowledge Motivation	24.72	0.001
Performance Motivation	29.32	0.001
Excitation Experience	5.62	0.02
Identical Regulation	4.45	0.04
Introjected Regulation	18.22	0.001
External Regulation	30.14	0.001
Lack of Motivation	28.32	0.001

As shown in Table 4, in connection with the motivation and all its components, regard to the significant level obtained (Sig.< 0.05), there is a linear relationship between the components in the experimental and control groups and the assumption of linearity for components is confirmed.

Table 5. Results of Covariance Analysis to Evaluate Significance of the Means Difference in the Critical Thinking Variable

Resource	Df	Ms	F	Sig.	η_p^2
Intercept	1	1734.811	90.642	0.001	0.381
Pretest	1	35037.085	1830.655	0.001	0.926
Group	1	4141.417	216.385	0.001	0.595
Error	147	19.139			

As seen in Table 5, according to the control of the effect of pretest on the posttest, the difference between the two groups in the posttest is statistically significant (Sig. = 0.001, F = 216.385). Therefore, considering the amount of (Sig.< 0.001), the research null hypothesis is rejected. In other words, the difference between groups is so great that they cannot be equated. This reflects the effectiveness of brainstorming teaching on the students' critical thinking. Chi ETA

also shows that 59% of changes are caused by the effect of brainstorming method.

Table 6. Analysis of Covariance of Academic Motivation

Resource	Df	Ms	F	Sig.	η_p^2
Intercept	1	1982.546	66.941	0.001	0.313
Pretest	1	10619.483	358.568	0.001	0.709
Group	1	9446.044	318.946	0.001	0.685
Error	147	29.616			

Regard to the total score of academic motivation, as seen in Table 6, according to the control of the effect of pretest on the posttest, the difference between the two groups in the posttest is statistically significant (Sig. = 0.001, F = 318.946). Therefore, considering the amount of (Sig. < 0.001), the research null hypothesis is rejected. In other words, the difference between groups is so great that they cannot be equated. This reflects the effectiveness of brainstorming teaching on the students' academic motivation. Chi ETA also shows that 68% of changes are caused by the effect of brainstorming method.

CONCLUSION

The results of calculating the mean and standard deviation of critical thinking test scores highlight the presence of difference in the mean scores of pretest and posttest in experimental group and show that the experimental group clearly did better in posttests related to the critical thinking. In connection with the first hypothesis, it can be stated that due to the significance of the between-group differences (Sig.< 0.001), which reflects the significant difference between pre-test and post-test in the experimental group, it can be concluded that brainstorming method influences the increase of critical thinking.

In the explanation of the point that how brainstorming impacts on critical thinking it can be stated that the studies emphasize the fact that critical thinking can be taught and one of the effective ways in promoting critical thinking level is brainstorming method ¹⁹. The main purpose of brainstorming method as a teaching method is to improve and expedite communication skills and contribute to the promotion of thinking and decision-making skills ²⁰. Teaching critical thinking is important to the extent that we make an individual literate. Critical thinking is classified in the family of cognitive abilities and is associated with creative thinking, problem solving and decision-making power. Critical thinking and creative thinking are associated with the production of effective thinking and problem solving ⁷.

The results of calculating the mean and standard deviation of motivation test scores highlight the presence of difference in the mean scores of pretest and

posttest in experimental group and show that the experimental group clearly did better in posttests related to the motivation. Considering the results of covariance analysis and its significance (Sig. < 0.001), which reflects the significant difference between pre-test and post-test in the experimental group, it can be concluded that brainstorming method influences motivation positively.

In the explanation of the point that how brainstorming impacts on motivation it can be stated that the students, taking part in teaching sessions, put all their focus and power on the achievement of the objectives set by research performer and ideal conditions are provided for their development. As a result this project leads to improve students' motivation and critical thinking. In other words, it can be concluded that more active teaching methods emphasize free elections of standards and values to achieve social - scientific facts based on democratic activity.

Therefore, the three principles of freedom, responsibility and choice play essential role in these play methods ⁷. In active teaching methods, learning is more stable. Students are often involved in higher levels of cognitive domain and the acquisitions of the learner penetrate the depth of emotional and behavioral areas. When you explain what you learn to another, you will learn much more of the time, you learn just by listening or reading something alone. The slogan of the interactive and cooperative class is that we can save either all or all drown. Therefore, the negative aspects of the students' competition disappear in these methods.

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