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Effect of Concept Mapping Teaching Strategy on Physical Science Achievement in Relation to Intelligence Level

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Abstract: In this present era, physical science education is very much depending on proper knowledge construction through meaningful learning process. This knowledge construction in physical science is processed through understanding of the relationship and hierarchy formation between important set of concepts. Concept mapping promotes this meaningful learning in physical science. Hence, the present study was carried out to investigate how far concept mapping teaching strategy has significant effect on physical science achievement in relation to intelligence level (High, Moderate and Low Intelligence). True experimental research design of randomized Solomon four equivalent groups was applied in this study. The study consisted of 41 sample of class IX student, selected from a Co-Ed school of Howrah district in West Bengal. For match group formation Mixed type Group Test of Intelligence (MGTI) by Mehrotra (2008) was used as a measuring tool. Achievement test in physical science (developed and standardized by the researchers) was used as another measuring tool for data collection. Descriptive statistics like mean, Variance, Standard Deviation, Standard Error of Mean etc. were applied for data analysis. Inferential statistics like "t" test and ANOVA were also applied for analyzing the result. Result of the study showed that changing in teaching strategy (concept mapping and demonstration) did not produce any significant difference among the high, moderate and low I.Q. students' achievement in class IX physical science subject.

Keywords: Concept Mapping, Physical Science, Achievement.

I. INTRODUCTION

Introduction: At present, the most widespread activity carried out in India is to create enthusiasm among the students on learning science. The government of India gives importance on those science disciplines by means of different activities. Inventing new science and technological apparatus, adopting new teaching-learning processes, popularizing science articles, organizing lectures, promoting various scholarship schemes and establishing various science centers etc. makes science education more structured and more meaningful to the learners. These efforts have come from individuals and from different private and public institutions who are trying to change the scenario of science education in India. "NCF – 2005 recommends that emphasis should be laid on the active participation of the learner in the construction of their knowledge"[14]. In this context concept mapping teaching strategy plays a significant role in physical science education on constructing knowledge in systematic and structural form. This is the reason for using concept mapping strategy in physical science teaching which has been widely used in present day.

Literature Review of the Study: After reviewing India and outside India literature of this study, it is shown that students taught through concept mapping strategy improves students' mastery of content at the higher-order levels of cognition and enhances their academic achievement level over conventional method. The same result has been seen in the following studies like- [2], [7], [9], [13], [16], [19], [20], [21] etc. It is also seen that there are some studies conducted on the relation between concept mapping strategy and attitude towards science subjects [1] etc. Through this strategy student's teaching-learning process should be flourished [22]. Collaborative learning, higher education of the students and motivation of the students - all are linked with the concept mapping teaching strategy. Studies of relation between concept mapping and mind mapping teaching strategy are also to be done by some researchers [10] etc. But a very few study is likely to be seen about the enhancement of science achievement through concept mapping teaching strategy in relation to students' intelligence level. Hence, from the above studies,

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it is clear that concept mapping teaching strategy has an enhancing impact on student's academic achievement.

Concept Map: Concept maps represent graphical tools to organize and construct the knowledge about certain concepts. This graphic organizer uses schematic representation of concepts to build meaningful statements. It represents frameworks for the interrelationships between the meaningful concepts. Concepts maps are as "a schematic device for representing a set of concept meaning embedded in a framework of propositions" [15]. It is also said that - "For the individual student, knowledge is organized as "internal concept maps" or schemata (psychological webs of interconnected pieces of information)"[18]. "Concept mapping is a generic term that describes any process for representing ideas in pictures or maps"[11].

Concept Map and Physical Science Achievement: Physical science includes study of physics and chemistry. Physics deals with the study of matter and energy whereas chemistry deals with the study of properties and uses of matter. It stimulates and excites pupils' curiosity about phenomena/event and satisfies their curiosity with knowledge. Physical science links direct practical experience with ideas. Through these practical activities learners can engage themselves. Concept maps promote these activities in proper way. Scientific concepts to be taught are chosen to make sense of everyday experiences. Sometimes learner faces some problems to summarize critical information. They did not able to describe concepts and/or organize ideas in proper and useful ways. For new subject matter memorizing purpose, learner leaves from this situation without relating new information with the existing knowledge. That's why their achievement towards physical science decreases day by day. In this context, it is said that "through this concept mapping teaching strategy science teaching-learning process becomes easier and student's achievement becomes significantly better than any other strategy" [6], [4] & [17].

In secondary level, physical science knowledge construction is very much essential which can be meaningfully achieved through the use of concept mapping strategy of teaching. Thus the present study is an attempt to investigate the "**Effect of Concept Mapping Teaching Strategy on Physical Science Achievement in Relation to Intelligence Level".**

Objective of the Study:

To compare the effect of concept mapping strategy and demonstration strategy on students' achievement in physical science with respect to their intelligence (High, Moderate & Low) at secondary level.

Hypothesis:

H_o: There is no significant difference among High, Moderate and Low intelligent students' achievement test score in physical science teaching through concept mapping strategy and demonstration strategy at secondary level.

Delimitations of the study: The study had following delimitations:

1) This study was delimited to the board of West Bengal Board of Secondary Education (W.B.B.S.E.) only.

2) The present study was conducted only on a Co-Ed school of Howrah district in West Bengal.

3) This study was delimited to class – IX standard of secondary level school.

II. METHODOLOGY

Research methodology is a science of studying how research is done scientifically and systematically manner. In it we scientifically study the various steps which are generally adopted by the researcher. From very beginning to end that is from the initial identification of problem of the study to its final conclusion, a systematic procedure is to be followed with the help of logical pathway. The present discussion is going on the finding the effect of concept mapping teaching strategy on physical science achievement in relation to intelligence level. The methodology adopted in this study is discussed in the following steps.

Method of the Study: In this study experimental method was used for controlling the variable and establishing a systematic & logical association between manipulated factors and observed effect.

Research Design: In this present study researcher had applied true experimental design of Randomized Solomon four Equivalent groups design. Intact classroom of 56 numbers of students of class IX of Gangadharpur Vidyamandir in Howrah, West Bengal was taken into the consideration for administering I.Q. test (Mixed group intelligence test (MGTI) by Mehrotra, 2008). On the basis of I.Q. test score matched group was developed for framing the experimental and control group. Each group consists of 28 numbers of students. Then the treatment was applied on the experimental group (teaching through concept mapping strategy) and demonstration teaching strategy was applied on the control group.

Research Paradigm: The research paradigm [12] of the study is shown in the following table 1:

Table 1: Research Paradigm:

Randomly Assigned	Pre-test (T1)	Independent Variable	Post-test (T2)
Experimental group (E)	T1E	Teaching through Concept Mapping Strategy	T2E
Control group (C1)	T1C1	Teaching through Demonstration Strategy	T1C1

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Control group (C2)	No Pre-test	Teaching through Concept Mapping Strategy	T2C2
Control group (C3)	No Pre-test	Teaching through Demonstration Strategy	T2C3

Sample of the Study: Through the random sampling technique 56 (28 for experimental group and 28 controlled group) class IX students of Gangadharpur Vidyamandir, a Bengali Medium Co-Ed School in the district of Howrah, West Bengal were selected as a sample for the study. Experimental group was taught through concept mapping strategy and the control group was taught through demonstration strategy. Due to the occurrence of experimental mortality and maintenance of normality of data 41 samples were finally considered (20 experimental group, 21 controlled group) for analysis and interpret the result.

Variables of the Study: Variables of the study were -

- Dependent Variable - Achievement in physical science.
- Independent Variable - Teaching strategy (teaching through concept mapping strategy and demonstration strategy).
- Categorical Variable - Intelligence level (High, Moderate & Low).
- Intervening Variable - Fatigue, anxiety, excitement and boredom of the students etc. were beyond the control of the researchers and may not be observed by the experimenter. Hence it remains uncontrolled throughout the experimentation.
- Extraneous variable - This variable was controlled by employing following techniques such as organizing matched group, technique of elimination, applying randomization process for chance selection, constancy of conditions and assignment of subjects to experimental and control groups.

Tools used for the Study: Tools used for the study were -

- **Measuring Tool –** 1. Mixed Type Group Test of Intelligence (MGTI) of Dr. P. N. Mehrotra (2008). 2. A self made achievement test based on the instructional objectives of Bloom's Revised Taxonomy was prepared for assessment.
- **Instructional Tool** – 1. A unit plan was prepared for teaching experimental group through concept mapping strategy. It was based on the unit of - "Matter: Structure of Atom, Physical & Chemical Properties of Matter" from physical science textbook of class IX syllabus of WBBSE. 2. A conventional unit plan was prepared for using in the teaching-learning process through demonstration strategy for the control group. 3. Teaching-learning materials such as five concept maps were prepared for giving instruction to the experimental group.

Procedure of data collection: On the basis of 'Mixed Type Group Test of Intelligence' score (T- score), class – IX standard students of 'Gangadharpur Vidyamandir' were matched into two groups. Group 1 was selected randomly as 'Experimental Group' and group 2 was selected randomly as 'Control Group'. Before the treatment applied researchers decided to take a pre-test (T1). At first self made achievement test was standardized then applied in Pretest (T1) and Posttest (T2) both. Experimental group was taught through concept mapping strategy and control group was taught through demonstration strategy. This treatment was going on for seven days. All the four groups were Post-tested (T2) after completing the treatment.

Software & techniques used for the Study: Following statistical techniques like Mean, Variance, Standard Deviation, Standard Error of Mean, 't'-test, ANOVA etc. had been used for tabulating and analyzing the data through Excel and SPSS software technique in both.

III. DATA ANALYSIS & INTERPRETATION

Part 1 - Test for Matched Group: Experimental and Control groups were matched on the basis of intelligence score (I.Q. Score). Single factor ANOVA was worked out on this I.Q. scores. Values are given in the following tables:

- **One way Single factor ANOVA Result:**

Table 2: Descriptive Statistics of I.Q. Score * Type of Group

Type of Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Experimental (E)-pre tested (CM)	10	31.900	9.3029	2.9418	25.245	38.555	13.0	47.0
Control (C1)-pre tested (DM)	10	34.700	10.7915	3.4126	26.980	42.420	12.0	48.0
Control (C2)-no pre-tested (CM)	10	32.500	10.1680	3.2154	25.226	39.774	18.0	53.0

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Control (C3)-no pre-tested (DM)	11	36.818	13.7537	4.1469	27.578	46.058	11.0	58.0
Total	**41**	**34.049**	**10.9635**	**1.7122**	**30.588**	**37.509**	**11.0**	**58.0**

Table 3: Test of Homogeneity of Variances of I.Q. Score

Levene Statistic	df1	df2	Sig.
0.586	3	37	**0.628**

Table 4: ANOVA result based on I.Q. Score

ANOVA	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	158.766	3	52.922	0.421	**0.739**
Within Groups	4649.136	37	125.652		
Total	**4807.902**	**40**			

Interpretation: Table 2, 3, and 4 reveals that the one way single factors ANOVA result. In table 2, it is shown that the descriptive statistics of I.Q. Score with respect to experimental and control groups. Mean I.Q. score of Experimental (E)-pre tested (CM) group, Control (C1)-pre tested (DM) group, Control (C2)-no pre-tested (CM) group, and Control (C3)-no pre-tested (DM) groups are 31.900, 34.700, 32.500 & 36.818 and their corresponding standard deviations are 9.3029, 10.7915, 10.1680 & 13.7537 respectively. Standard errors of mean of these groups are 2.9418, 3.4126, 3.2154 & 4.1469 respectively. Table 3 shows the test of Homogeneity of Variances of I.Q. Score. The Sig. value of I.Q. score is 0.628, which is greater than 0.05 ($p>0.05$). Table 4 indicates that Analysis of Variance (ANOVA) of I.Q. score in relation to experimental and control groups. From the table 4, it has been found that the Sig. value is 0.739, which is greater than 0.05 ($p>0.05$). Hence, 'F' is not significant at 0.05 level of significance. Thus, from one way single factor ANOVA test, it can be concluded that there is no significant difference present among Experimental (E)-pre tested (CM) group, Control (C1)-pre tested (DM) group, Control (C2)-no pre-tested (CM) group, and Control (C3)-no pre-tested (DM) groups. All these groups are equivalently matched on the basis of intelligence.

Part 2 - Test for H_0: To investigate the significant difference among High, Moderate and Low intelligent students' achievement in Physical Science taught through Concept mapping and Demonstration strategy, the descriptive statistics and two way ANOVA techniques was applied for analyzing the data. For testing the null hypothesis (H_0), researcher had decided to analyze the Posttest (T2) achievement score in physical science of High, Moderate and Low intelligent students, taught through Concept Mapping and Demonstration strategy by using descriptive statistics. The values are given in table 5. Two way ANOVA result is shown in table 7 below:

Table 5: Descriptive Statistics of I.Q. based Group * Teaching Strategy

Dependent Variable: Post test (T2)

IQ Based Group	Teaching Strategy	Mean	Std. Deviation	N
Low	Concept Mapping (CM)	7.400	1.9494	5
	Demonstration (DM)	7.500	2.3805	4
	Total	**7.444**	**2.0069**	**9**
Moderate	Concept Mapping (CM)	8.308	2.1364	13
	Demonstration (DM)	7.727	2.1490	11
	Total	**8.042**	**2.1158**	**24**
High	Concept Mapping (CM)	9.000	2.8284	2
	Demonstration (DM)	7.833	0.9832	6
	Total	**8.125**	**1.4577**	**8**
Total	**Concept Mapping (CM)**	**8.150**	**2.0844**	**20**

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	Demonstration (DM)	**7.714**	**1.8478**	**21**
	Total	**7.927**	**1.9544**	**41**

Fig. 1: Graphical representation of Mean Achievement Score in Posttest (T2) of I.Q. based group in relation to Teaching Strategy:

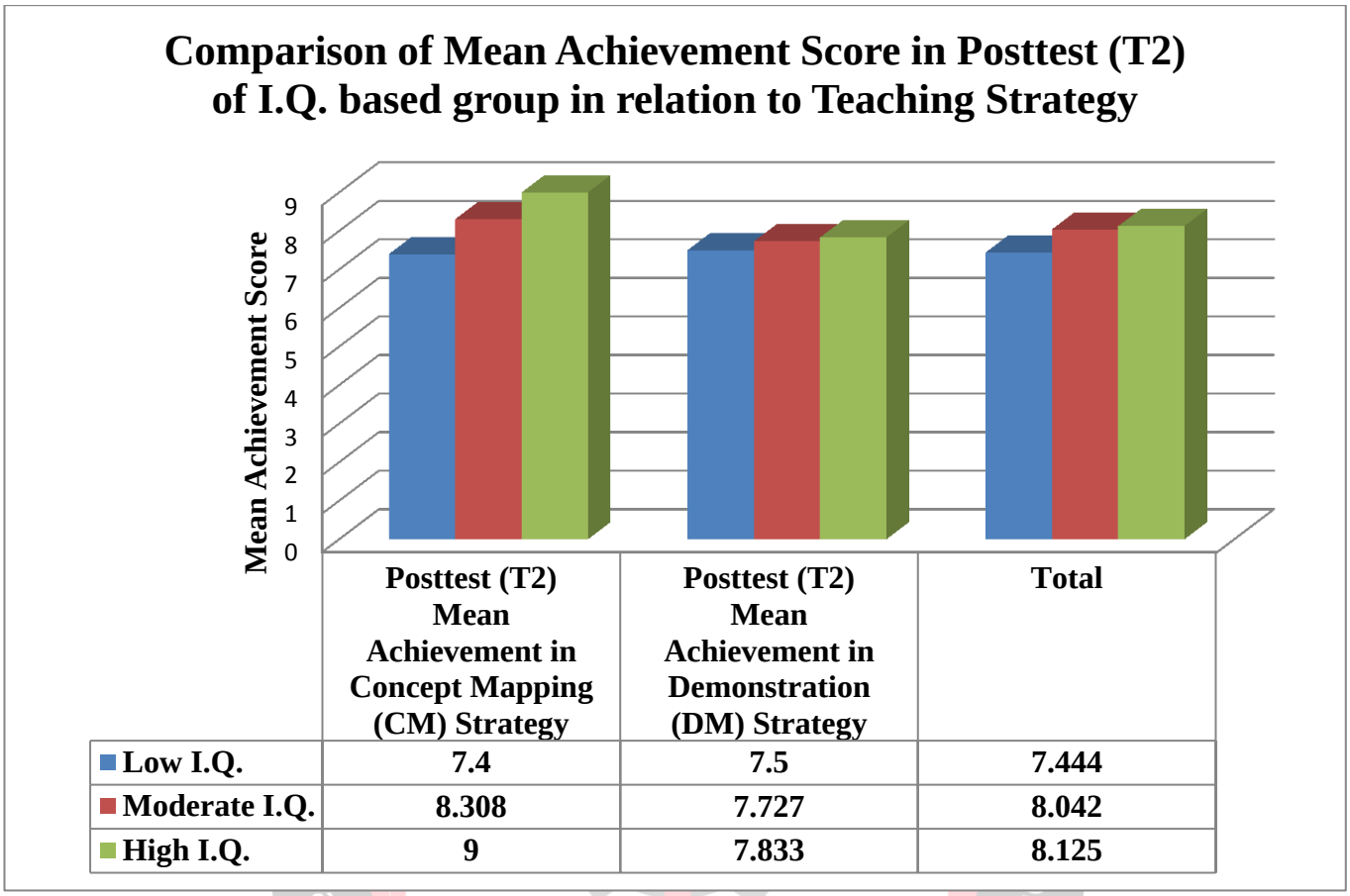

Table 6: Levene's Test of Equality of Error Variances

Dependent Variable: Post test (T2)

F	**df1**	**df2**	**Sig.**
0.799	5	35	**0.558**

Table 7: Tests of Between-Subjects Effects

Dependent Variable: Post test (T2)

Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	6.796[a]	5	1.359	0.326	0.894
Intercept	1776.421	1	1776.421	425.900	0.000
I.Q. based group	3.637	2	1.819	0.436	0.650
Teaching Strategy	2.112	1	2.112	0.506	0.481
I.Q. based group * Teaching Strategy	1.503	2	0.752	0.180	**0.836**
Error	145.984	35	4.171		
Total	**2729.000**	**41**			
Corrected Total	**152.780**	**40**			

a. R Squared = 0.044 (Adjusted R Squared = -0.092).

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Interpretation: Table 5 reveals that in posttest (T2) of low I.Q. students taught through concept mapping and demonstration strategy, the mean achievement score are 7.400 & 7.500 respectively and their corresponding standard deviation of achievement score are 1.9494 & 2.3805 respectively. For moderate I.Q. students taught through concept mapping and demonstration strategy, the mean achievement score in posttest (T2) are 8.308 & 7.727 respectively and their corresponding standard deviation of achievement score in posttest (T2) are 2.1364 & 2.1490 respectively. And for high I.Q. students taught through concept mapping and demonstration strategy, the mean achievement score in posttest (T2) are 9.000 & 7.833 respectively and their corresponding standard deviation of achievement score in posttest (T2) are 2.8284 & 0.9832 respectively. A graphical representation of mean achievement score in Posttest (T2) of I.Q. based group in relation to teaching strategy is shown in fig. 1.

Table 6 shows the Levene's Test of Equality of Error Variances. Sig. value of Levene's Test for Equality of Error Variances shows 0.558, which is greater than 0.05 (p>0.05). Hence, 'F' is not significant at 0.05 level of significance. It indicates that three groups have equal variances.

In the table 7, tests of between-subjects effects are shown. It indicates that the two-way Analysis of Variance (ANOVA) of Posttest (T2) achievement score in relation to I.Q. based group and teaching strategy both. From the above table it has been found that the Sig. value of I.Q. based group is 0.650, which is greater than 0.05 (p>0.05). Hence, 'F' is not significant at 0.05 level of significance. That is no significant difference present among the High, Moderate and Low intelligent students in Posttest (T2) achievement score. Also it has been found that the Sig. value of teaching strategy is 0.481, which is greater than 0.05 (p>0.05). Hence, 'F' is not significant at 0.05 level of significance. That is no significant difference present between concept mapping and demonstration strategy in their Posttest (T2) achievement score. And in the interaction between the I.Q. based group and teaching strategy, the sig. value is 0.836, which is greater than 0.05 (p>0.05). Hence, 'F' is not significant at 0.05 level of significance. Therefore, the null hypothesis is not rejected at 0.05 level of significance. Thus, it is concluded that no significant interaction present in Posttest (T2) achievement score in physical science taught through concept mapping and demonstration strategy to different groups with respect category of intelligence.

IV. FINDINGS & SUGGESTIONS

Major Findings: There was no significant deference present in Posttest (T2) achievement score in physical science taught through concept mapping and demonstration strategy in relation to their intelligence level (High, Moderate & Low). Hence, null hypothesis (H_0) is accepted in the present study. But concept mapping teaching strategy had significant effect on high and moderate intelligent students with respect to low intelligent students. Mean achievement Posttest (T2) score of low I.Q. students in physical science taught through concept mapping strategy (Mean = 7.400) is slightly lower than taught through demonstration strategy (Mean = 7.500). Mean achievement Posttest (T2) score of moderate I.Q. students in physical science taught through concept mapping strategy (Mean = 8.308) is greater than taught through demonstration strategy (Mean = 7.727). In case of mean achievement Posttest (T2) score of high I.Q. students in physical science taught through concept mapping strategy (Mean = 9.000) is higher than taught through demonstration strategy (Mean = 7.833).

Limitations of the Study: Researchers have faced some problems during this study. These are the limitations of this present study. These are to be considered for the future researchers on their research work. Some of those limitations were: 1) Due to shortage of time period, the total instructional unit did not complete by the researcher. 2) A good rapport between students and teacher was not established properly during this short period. 3) If the study will conduct in a residential school then it will give a better result. 4) Experimental mortality is the major limitation in this study.

Suggestions for future Research: Some suggestions are given for the future research purpose. These are:

- Present study was conducted on the secondary level school students of W.B.B.S.E. only. Further study can be conducted on the other group of students at deferent level of C.B.S.E. board & I.S.C. board.
- This study was conducted on physical science achievement of student at secondary level. Further study can be conducted on specific branches of science like Physics, Chemistry, Biology, Mathematics etc. and non-science subjects like Geography, etc.
- The present study was conducted on class IX standard students only. Further study can be conducted on deferent class by taking deferent context.
- A study can be performed to investigate the attitude towards the application of concept mapping teaching strategy on student's achievement.
- Use of software regarding the administration of concept mapping strategy in classroom is an emerging topic to investigate in this present situation.
- The present study was conducted with 41 samples. Further study can be undertaken by taking larger sample.
- A study can be conducted on the rural area by using concept mapping teaching strategy.

V. CONCLUSION

From the above analysis, interpretations and findings, it can be easily concluded that no significant difference present in Posttest (T2) achievement test score in physical science

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taught through concept mapping and demonstration strategy in relation to their intelligence level (High, Moderate & Low). Thus in respect to the present context, changing in teaching strategy (concept mapping and demonstration) did not produce any significant difference among the high, moderate and low I.Q. students' achievement in class IX physical science subject. But after getting feedback from students, it is concluded that concept mapping teaching strategy is more effective for achieving better result than the demonstration teaching strategy in their acquisition of knowledge through meaningful learning process in physical science complex concept. In this study, it is observed that high and moderate intelligent students are more beneficial in physical science mean achievement score than low intelligent student. It is shown in the research that "achievement level – achievement interactions favoring low achievers" [3]. Another research shows that - "The second method (made of activities and manipulations of objects along with some verbal interactions) was found superior especially with average & low achieving students but not in the case of high achievers" [5]. Thus, it is nicely said in this context that - "The concept mapping strategy was found to be advantageous only for students whose cognitive ability was below the median for the sample and who were placed in groups with other students having low cognitive ability" [8].

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