International Journal of psycho-educational sciences
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The Effect of Metacognitive Strategy Training on science process skills and science self efficacy among first year prep students with learning disabilities

Omema Mostafa Kamel Gomaa [1]

[1] Associate professor of Educational Psychology , Cairo University, Specific Education College , Egypt

Abstract

This *study investigated the effect of using metacognitive strategy training on science process skills and science self efficacy in learning disabled first year prep students . A total of 60 students identified with LD were invited to participate. The sample was randomly divided into two groups; experimental (n= 30 boys)and control (n= 30 boys). ANCOVA and Repeated Measures Analyses were employed for data analysis. Findings from this study indicated the effectiveness of the program employed in improving science process skills and science self efficacy in the target students. On the basis of the findings, the study advocated for the effectiveness of using metacognitive strategy training on science process skills and science self efficacy in learning disabled first year prep students .*

Key Words; metacognitive strategy training, science process skills, science self efficacy ,learning disabled.

Introduction

Science is one of the great expressions of humanity. Science is simultaneously a body of knowledge and a way of gaining and using that knowledge. The accumulated and systematized body of knowledge, which is the 'product' of science, has a dynamic counterpart, the methods of inquiry, which is the 'processes' of science. Science is thus a combination of both 'processes' and 'products' related to and dependent upon each other. A Process is a series of activities or operations performed to attain certain goals or products. Science Processes are the inter-linked activities performed by any qualified person during the exploration of the universe. The meaning of the "process of science" is expressed in many ways (Sheeba, 2013).

Science process skills are the basis for scientific thinking and research (Mutlu and Temiz, 2013). Tobin and Capie (1982) define science process skills as identifying a problem, formulating a hypothesis about the problem, making valid predictions, identifying and defining of variables, designing an experiment to test the hypotheses, gathering and analyzing data and presenting rational findings that support the data.

Science process skills are a reflection of the methods used by scientists while generating information on science. The science process skills include intellectual skills, associated psychomotor and affective skills that are concerned with the learning of science in all its aspects. A review of literature enlists the skills pertaining to the various domains. The skills in the cognitive domain include comparing, communicating, inferring, predicting, using number relations, using time/space relations/making operational definitions, framing hypotheses, controlling variables, interpreting data, generalizing, raising questions, applying, quantifying, evaluating, designing investigations, finding relationships and patterns. Skills of observing, classifying, manipulating, experimenting and measuring pertain to the psychomotor domain while those in the affective level include wondering 'why', enjoying the aesthetics of discovery, 'aha' experience, suspending judgment, persevering amidst difficulty and ambiguity and the readiness to give up pet hypotheses in the face for strong evidence to the contrary. These process skills are helpful in furthering their knowledge in Science and other disciplines(Sheeba, 2013).

Self-efficacy is people's judgments of their capabilities to organize and execute courses of action required to attain types of performances (Bandura, 1986, p. 391). Self-efficacy affects choice of activities, effort and persistence. People holding low self-efficacy for accomplishing a task may avoid it; those who believe they are capable are likely to participate. Especially when they encounter difficulties, efficacious students work harder and persist longer than those with doubts. People acquire information to appraise self-efficacy from their actual performances, vicarious (observational) experiences, forms of persuasion and psychological symptoms (Pintrich & Schunk, 2002).

Metacognition

Metacognition includes skills that enable learners to understand and monitor their cognitive processes (Schraw, Crippen & Hartley, 2006). According to Schraw's model (1998), there are two main subcomponents in the matecognition:

1. Knowledge of cognition refers to what individuals know about their own cognition or about cognition in general. It includes three different kinds of metacognitive awareness: declarative, procedural and conditional knowledge.

∞ Declarative knowledge includes knowledge about oneself as a learner and about factors that influence one's performance (knowing 'about' things).

∞ Procedural knowledge refers to knowledge about doing things. Much of this knowledge is represented as heuristics and strategies (knowing 'how' to do things).

∞ Conditional knowledge refers to knowing when and why to use declarative and procedural knowledge (knowing the 'why' and 'when' aspects of cognition).

2. Regulation of cognition refers to a set of activities that help students control their learning. Although a number of regulatory skills have been described in the literature, three essential skills are included in all accounts: planning, monitoring and evaluation.

∞ Planning involves the selection of appropriate strategies and the allocation of resources that affect performance. Planning includes goal setting, activating relevant background knowledge and budgeting time.

∞ Monitoring includes the self-testing skills necessary to control learning. It refers one's on-line awareness of comprehension and task performance.

∞ Evaluation refers to appraising the products and efficiency of one's learning. Re-evaluating one's goals, revising predictions and consolidating intellectual gains.

A research by Moghtaderi& Khanjani (2012) showed that self efficacy is related to high levels of using cognitive and meta-cognition strategies as well as involvement and sustainability in homework completion. Other researchers(Britner & Pajares, 2006; Zusho et al., 2003) assert that high self-efficacy is associated with greater metacognition, including more efficient use of problem solving strategies and management of working time, expending greater effort, and persisting longer to complete a task, particularly in the face of obstacles and adversity. Furthermore, students with high self-efficacy tend to use metacognitive strategies to generate successful performance outcomes(Braten, et al., 2004, Pintrich & De Groot , 1990).

So, present research study seeks to explore the effect of metacognitive strategy training on science process skills and science self efficacy among first year prep students with learning disabilities . It addresses the following questions:

Are there differences in post – test scores mean between control and experimental groups on science process skills test ?

2- Are there differences in post – test scores mean between control and experimental groups on science self efficacy test ?

3- If the programme is effective in improving science process skills of experimental group, is this effect still evident a month later?

4- If the programme is effective in improving science self efficacy of experimental group, is this effect still evident a month later?

Method

Participants

60 students participated in the present study. Each student participant met the following established criteria to be included in the study: (a) a diagnosis of LD by teacher's references, and learning disabilities screening test (Kamel, 1990) (b) an IQ score on the Mental Abilities Test

(Mosa, 1989) between 90 and 118 (c) absence of any other disabling condition. The sample was randomly divided into two groups; experimental (n= 30 boys) and control (n= 30 boys)

The two groups were matched on age, IQ, science process skills and science self efficacy . Table 1. shows means, standard deviations, t- value, and significance level for experimental and control groups on age (by month) ,IQ , science process skills and science self efficacy (pre-test).

Table 1. means, standard deviations , t- value , and significance level for experimental and control groups on age (by month),IQ, science process skills and science self efficacy (pre-test).

Variable	Group	N	M	SD	T	Sig.
Age	Experimental	30	156.24	1.96	-.121	Not sig.
	Control	30	156.41	2.01		
IQ	Experimental	30	111.34	4.45	-.221	Not sig.
	Control	30	111.89	4.24		
science process skills	Experimental	30	6.21	3.00	-.547	Not sig.
	Control	30	6.67	3.52		
Science self efficacy	Experimental	30	24.80	2.65	-.539	Not sig.
	Control	30	25.83	2.32		

Table 1. shows that all t- values did not reach significance level . This indicated that the two groups did not differ in age (by month),IQ, science process skills and science self efficacy (pre-test).

Instruments

1- Science process skills test (SPST) consisting of (22) items that tests basic and integrated science process skills that was based on the relevant literature (Monica, 2005; Ngoh, 2009; Afif & Majdi ,2015). There are 12 items on the basic science process skills, 10 items on the integrated science process skills. Table 2 shows the respective science process skills.

Table 2. Distribution of the Science Process Skills

Science Process Skills Items	***Basic***	***Science Process Skills Items***	***Integrated***
1, 2 , 3	Observation	13,14	Controlling variables
4,5	Measuring	15,16	Hypothesizing
7,8	Classifying	17,18	Experimentation
9,10	Predicting	19,20	Data Interpreting
11,12	Communicating	21,22	

The Cronbach's α for the test was (0.95). This reliability made the instrument suitable for this study.

2- Me and Science : Science Self-Efficacy: Me and Science was developed for two purposes: one, to provide an intermediate rather than specific measure of math self-efficacy, and two, to provide a scale which might profile students' strong or weak self-efficacious characteristics. There are three factors: Effort, ability , and resiliency .

In completing Me and Science, students were instructed to respond by thinking how they felt about themselves with reference to math using a three point Likert scale (agree=3, Uncertain= 2 , and Disagree=1). Reliability coefficients were computed for the full scale (Science self-efficacy) and subscales (ability, effort, resiliency). These results were -91 for Social Studies self efficacy, .93 for ability, -73 for effort, and -80 For resiliency.

Procedures

Screening : Second year prep students who participated met the following established criteria to be included in the study: (a) a diagnosis of LD by teacher's references, and learning disabilities screening test (Kamel, 1990) (b) an IQ score on the Mental Abilities Test (Mosa, 1989) between 90 and 118 (c) absence of any other disabling condition.

Pre-intervention testing : All the sixty students in grade one prep completed Science process skills test , and Me and science : science Self-Efficacy, which assesses students' self efficacy in science. Thus data was reported for the students who completed the study .

General Instructional Procedures: Instruction was delivered to The first year Science teacher. Before the study started, the science teacher participated in 10 hours of training to learn how to implement the metacognitive training strategy . The teacher was provided with a notebook that contained detailed directions for implementing all activities and lessons.

The teacher; Mrs. Salma, received training and role-played implementing the strategy until she was able to do so to criterion. To help ensure complete implementation, she was provided with a checklist for each lesson. As she taught a lesson, each step was checked as it was completed.

The teacher , however, had the flexibility to respond to individual student needs, backing up and repeating a step, if necessary, or reordering steps. Students received 3 training sessions a week, lasting between 40 and 45 min . Instruction took place in the regular classroom in order to naturalize the situation.

Design and Analysis

The effects of implementing the metacognitive training strategy on students' science process skills and science self efficacy were assessed using a repeated-measures design, pre- post- and follow-up testing.

Results

Table 3. shows data on ANCOVA analysis for the differences in post- test mean scores between experimental and control groups in Science process skills test. The table shows that the (F) value was (128.009) and it was significant value at the level (0.01).

Table 3. ANCOVA analysis for the differences in post- test mean scores between experimental and control groups in Science process skills test

Source	Type 111 sum of squares	df	Mean square	F	Sig.
Pre	1.725	1	1.725		
Group	217.276	1	217.276	128.009	0.01
Error	317.340	57	5.567		
Total	1067.933	59			

Table 4. shows T. test results for the differences in post- test mean scores between experimental and control groups in Science process skills test. The table shows that (t) vale was (11.67). This value is significant at the level (0.01) in the favor of experimental group . The table also shows that there are differences in post- test mean scores between experimental and control groups in Science process skills test in the favor of experimental group .

Table 4. T- test results for the differences in post- test mean scores between experimental and control groups in Science process skills test

Group	N	Mean	Std. deviation	T	Sig.
Experimental	30	13.50	1.10	11.67	0.01
Control	30	6.43	3.12		

Table 5. shows data on ANCOVA analysis for the differences in post- test mean scores between experimental and control groups in Science self efficacy . The table shows that the (F) value was (131.099) and it was significant value at the level (0.01).

Table 5. *ANCOVA analysis for the differences in post- test mean scores between experimental and control groups in Science self efficacy*

Source	Type 111 Sum of squares	df	Mean square	F	Sig.
Pre	17.004	1	17.004		
Group	30055.895	1	30055.895	131.099	0.01
Error	13067.862	57	229.261		
Total	43369.933	59			

Table 6. shows T. test results for the differences in post- test mean scores between experimental and control groups in science self efficacy. The table shows that (t) vale was (11.568). This value is significant at the level (0.01) in the favor of experimental group. The table also shows that there are differences in post- test mean scores between experimental and control groups in science self efficacy in the favor of experimental group.

Table 6. T. test results for the differences in post- test mean scores between experimental and control groups in science self efficacy

Group	N	Mean	Std. deviation	T	Sig.
Experimental	30	83.83	1.64	11.568	0.01
Control	30	38.90	3.81		

Table 7. shows data on repeated measures analysis for Science process skills test. The table shows that there are statistical differences between measures (pre- post- sequential) at the level (0.01).

Table *7 . Repeated measures analysis for Science process skills test.*

Source	Type 111 sum of squares	df	Mean square	F	Sig.
Between groups	661.250	1	661.250		0.01
Error 1	105.611	58	1.821	363.148	
Between Measures	794.978	2	794.978	193.121	0.01
Measures x Groups	596.933	2	298.467	145.011	0.01
Error 2	238.756	116	2.058		

Table 8. shows data on Scheffe test for multi-comparisons in Science process skills test. The table shows that there are statistical differences between pre and post measures in favor of post test , and between pre and follow up in favor of follow up test , but no statistical differences between post and follow up test .

Table 8. *Scheffe test for multi- comparisons in Science process skills test*

Measure	Pre M= 6.76	Post M= 13.20	Follow up M= 12.86
Pre	--	--	--
Post	8.43*	--	--
Follow up	8.10*	.33	--

Table 9. shows data on repeated measures analysis for science self efficacy. The table shows that there are statistical differences between measures (pre- post- follow up) at the level (0.01).

Table 9. *Repeated measures analysis for science self efficacy*

Source	Type 111 sum of squares	df	Mean square	F	Sig.
Between groups	50200.200	1	50200.200	590.551	0.01
Error 1	4930.333	58	85.006		
Between Measures	25297.033	2	12648.517	123.776	0.01
MeasuresxGroups	25515.700	2	12757.850	124.846	0.01
Error 2	11853.933	116	102.189		

Table 10. shows data on Scheffe test for multi-comparisons in science self efficacy test. The table shows that there are statistical differences between pre and post measures in favor of post test, and between pre and follow up measures in favor of follow up testing , but no statistical differences between post and follow up testing .

Table 10 . *Scheffe test for multi-comparisons in science self efficacy*

Measure	Pre M= 39.20	Post M= 83.83	Follow up M= 85.13
Pre	--	--	--
Post	44.633*	--	--
Follow up	45.933*	1. 300	--

Discussion

This study sought to determine the effects of the metacognitive training strategy in improving science process skills and science self efficacy of first year prep students with learning disabilities.

The results of this study showed that the metacognitive training strategy was effective in improving science process skills and science self efficacy of students in experimental group, compared to the control group whose individuals were left to be taught in a traditional way .

Participants of this study fall into the minimum IQ of 90, nevertheless, they have learning disability. Thus IQ score cannot account for learning disabilities. The results of the present study support that conclusion with evidence that students who participated in the study do not fall into the low IQ range, however they have learning disabilities. When designing a program based on the metacognitive training strategy, they had statistical increase in science process skills and science self efficacy. This goes in line with what Mourad Ali et al. (2006) notes that there is one problem " students who are identified as learning disabled often cover any special abilities and talents, so their weakness becomes the focus of their teachers and peers , ignoring their abilities.

Mourad Ali (2007) , however , notes that " learning disabled , as well as gifted students can master the same contents and school subjects ", but they need to do that in a way that is different from that used in our schools .

Experimental group gained better scores in science process skills and science self efficacy tests than did control groups in post-tests though there were no statistical differences between the two groups in pre- test. This is due to the program which met the experimental group's needs and interests. On the contrary, the control group was left to be taught in a traditional way. This goes in line with our adopted perspective which indicates that traditional methods used in our schools do not direct students as individual toward tasks and materials , and do not challenge their abilities. This may lead students to hate all subjects and the school in general. On the contrary, when teachers adopt a technique that suits students interests and challenges their abilities with its various modalities , those students had a lot of gains .

Implications

The results of this study have several important implications. This study adds to the literature on the effectiveness of metacognitive training strategy with learning disabled students. Results appear to indicate that metacognitive training strategy is an effective instructional strategy for improving science process skills and science self efficacy test scores of students with learning disabilities.

References

Afif ,H. & Majdi ,R.(2015). Science Process Skills and Attitudes toward Science among Palestinian Secondary School Students. *World Journal of Education*, 5(1), 13-24.

Bandura, A. (1986). *Social foundations of thought and action: A social-cognitive view*. Englewood Cliffs, NJ: Prentice-Hall.

Braten, I., Samuelstuen, M. S., & Stromso, H. I. (2004). Do students' Self-efficacy Beliefs Moderate the Effects of Performance Goals on Self-Regulatory Strategy Use? *Educational Psychology*, 24, 231-247.

Britner, S. L., & Pajares, F. (2006). Sources of Science Self-Efficacy Beliefs of Middle School Students. *Journal of Research in Science Teaching*, 43(5), 485.

Kamel, M. (1990) Screening Student test for learning disabilities , Cairo, Al Anglo

Moghtaderi, L. & Khanjani,Z. (2012). The effectiveness of training cognitive /meta-cognition strategy on self-efficacy and ability of mathematical problem-solving for students with dyscalculia. *Jokull journal* , pp. 173-195.

Monica, K. (2005). *Development and validation of a test of integrated science process skills for the further education and training learners*. Unpublished Master's thesis, University of Pretoria. South Africa.

Mosa, Farouk. A.(1989) *Mental Ability Test*, Cairo, El Nahda Al Masrya .

Mourad Ali (2007) . *How the reading disabled brain learns , Alexandria* , Dar El Wafaa.

Mourad Ali, E. Waleed El sayed,& Ahmed Gomaa (2006). *Computer and learning disabilities, theory and practice*, Alexandria, Dar El Wafaa

Mutlu M, Temiz BK (2013). Science process skills of students having field dependent and field independent cognitive styles. *Educational Research Review* , 8(11):766 -776.

Ngoh, T. (2009). *Mastery of the science process skills*. Unpublished manuscript.

Pintrich, P. R, & De Groot, E V. (1990). Motivational and self-regulated Learning components of classroom academic performance. *Journal of Educational Psychology* , 82(1), 334.

Pintrich, P. R., & Schunk, D. (2002). M*otivation in education: Theory, research, and applications* (2nd ed.). Upper Saddle, NJ: Prentice-Hall, Inc.

Schraw, G. (1998). Promoting general metacognitive awareness. *Instructional Sciences*, 26, 113-125.

Schraw, G., Crippen, K.J. & Hartley, K. (2006). Promoting Self-Regulation in Science Education: Metacognition as Part of a Broader Perspective on Learning. *Research in Science Education*, 36, 111-139.

Sheeba,M.(2013). An Anatomy of Science Process Skills In The Light Of The Challenges to Realize Science Instruction Leading To Global Excellence in Education. *Educationia Confab*,. 2(4), April, 108-123.

Tobin KG, Capie W (1982). Relations hips between formal reasoning ability, locus of control, academic engagement and integrated process skills achievement. *Journal of Research in Science Teaching* , 19:113-121.

Zusho, A., Pintrich, P. R., & Coppola, B. (2003). Skill and Will: The Role of Motivation and Cognition in the Learning of College Chemistry. *International Journal of Science Education*, 25, 1081-1094.