Document Type: Original Article
https://dorl.net/dor/20.1001.1.26455455.2021.4.13.2.2

Iranian Journal of Learning and Memory, 2021, 4(13), 20-28

A Comparative Study on the Effectiveness of Metacognitive and Problem Solving Training on the Awareness of Teaching – Learning Strategies of High School Gifted Male Students in Ardabil

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Abstract

The aim of this study was to compare the effectiveness of metacognition and problem solving training on teaching-learning strategies awareness of gifted high school male students of 10th grade in Ardabil. This research is a quasi-experimental research, with a pre-test/ post-test design. 127 gifted high school male students of Ardabil were participated in the study as the statistical population in 2017-18 academic year. Sixty of these students were selected through simple random sampling. Before starting the training programs, three groups were tested by the Weinstein Teaching-Learning Strategies Questionnaire first developed by Weinstein and Schultz (1987). Metacognitive training program was taught for the first experimental group, and problem solving skills program was taught for the second experimental group; each training program consisted of eight two-hour sessions and the control group did not receive any kind of training. Pre-test and post-test results were analyzed using MANOVA. The results showed that both metacognitive and problem solving training enhance teaching and learning skills and that metacognitive training is more effective in terms of test strategies, attitudes, focus, and time management. Also, similar effects were achieved in terms of information processing and selection of the main idea, anxiety, motivation, self-examination, study guide in the two groups. In conclusion, metacognitive training was proven to be more effective than problem solving training.

***Keywords*:** Gifted students, metacognitive training, problem solving training, teaching-learning

Introduction

One of the problems that most students always face during their studies is the issue of learning. We usually expect learners to learn, but it rarely happens that we teach learners how to learn. We want the students to solve the problems, but we rarely teach them how to solve the problems. We expect our students to remember a lot of information, but we do not teach them how to do that (Aghazade, 2009). One of the most important concerns of education officials and students' families is students' academic achievement and prevention of their academic failure. One of the reasons for academic failure can be related to the weakness of their study and learning skills; however, the ultimate goal of educational system is learning. Any factor that contributes to the realization of this goal must be considered. The more students use the correct study strategies, the more they can be aware of this issue; therefore, the learning environment ought to be designed in such a way that it leads learners to learn as much as possible, and provide them with some better academic progress (Samadi, 2012).

Learning strategies have a plain structure in which learners are able to learn educational material faster and keep them in mind for a longer period of time. By applying learning strategies and continuous monitoring of the learning flow, learners will be actively involved in

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Received: 11/21/2020
Accepted: 05/29/2021

the learning process (Seif & Masrabadi, 2003). Many studies show that learning disabilities are related to the cognitive processes in the brain and the way of information processing (Swanson, 2015). Misrabadi and Erfani (2014) in a meta-analysis of the relationship between learning strategies and academic achievement stated that in general, learning strategies of any kind, in all research and in all learners have a great impact on students' learning in different subjects. Jalili, Hejazi, Entesar and Morvati (2018) in examining the relationship between metacognition and academic performance with problem solving mediation concluded that the use of problem solving skills and metacognition leads to a significant growth of learning in students.

The results of various studies have shown that unsuccessful students have poor studying habits and academic skills than students who have more academic achievement. Learners who use the right study strategies are successful in retrieving information and have higher academic achievement, but learners who doesn't use these strategies, have less academic achievement (Zarei & Marandi, 2011). Because the intellectual skills and mental strategies that students use in reading and learning can be taught, students' learning and study strategies can be modified through educating and training.

Ineffective learning, in addition to economic losses, can lead to problems such as frustration, low self-esteem, feelings of inferiority, and depression, and consequently can lead to failure of talent and abilities of the failed student (Ayers & Reader, 1998). Students are different in terms of learning capacities. Allocating some special schools to gifted students is meant to give them an opportunity to speed up and deepen their learning. The gifted students surveyed in this study enter these schools every year based on the entrance exam and have high academic intelligence and talent, and in an effort to learn better and more usefully, they must adjust their learning strategies and acquire more skills to achieve academic success.

One of the areas that have been much discussed in recent years in teaching-learning strategies is the role of metacognitive beliefs in the teaching-learning process of the learners. Cognition is the internal mental processes and the ways by which we pay attention to information, understand it, encode it, and store it in our memories (Bilerem & Snowman; quoted in Seif, 2013). Metacognition is to know the cognition or knowing about knowledge. More precisely, "metacognition is the knowledge of an individual about how he is learning" (Slavin, 2008). Findings show that students with learning disabilities are weaker in the metacognitive points of view (Hallahan, Kaufman & James, 2007). Thus, cognitive strategies are needed as a powerful tool to master complex tasks such as problem solving (Tolar, Fuchs, Fletcher, Fuchs & Hamlet, 2016).

Based on the results of Ghadampour, Khalili, and Rezaeian (2016), package of metacognitive training increases students' academic achievement. Results of Rahimi and Shojaeizadeh (2015), Panadero (2017), Emily, Freeman, and Kerry (2017), Tolar et al. (2016), Swanson (2015), Shaykhaleslam, Barzegar and Khodaverdi (2013) indicate the effectiveness of metacognition education on the components of teaching-learning strategies and academic achievement. Based on the findings of Soleimani et al., (2018), providing an intervention based on teaching metacognitive strategies has been effective in improving information processing.

However, some previous researches have shown that learning strategies do not have an effective contribution to improving learners' learning. For example, Masoumi (2007) concluded that there is no significant difference between students' learning in the two groups of cognitive and metacognitive experiments. Also, the results of Quixin (2012) showed that cognitive strategies have the strongest effect on English language scores, but metacognitive strategies could not predict scores of the linguistic lessons.

Another social skill that plays an important role in academic achievement and self-regulated learning is problem solving skill. Problem-solving skills are cognitive-behavioral processes by which individuals identify and discover effective strategies for dealing with problematic situations in daily life. Problem solving requires specific and purposeful strategies by which a person defines problems, decides to take solutions, implements and monitors problem solving strategies (Behzadpour, Motahhari & Goodarzi, 2013). In solving a problem, finding a specific solution for a specific problem is not considered. It is important, as a result of solving the problem, to obtain an abstract principle or law that can be generalized to other situations. This is why the learning obtained from problem solving is more transferable to new situations than other learning strategies (Khoshkam, Malekpour, & Molavi, 2008). Problem solving training is a method by which a student learns to use his / her effective cognitive skills set to solve problematic situations (Perla & Donnell, 2004). Findings of Daresh, Shahi and Razavi (2018), Ghadmpour et al. (2018), Molnar and Csapo (2018), Martin, Donohoe, and Holdford (2016), and Lau (2014) stated that problem-solving learning is an active and powerful type of learning that prepares a person to deal with real-life experiences. They showed that there is a significant relationship between problem solving teaching method and learning rate.

Other studies have shown that learners who are participated in problem-solving, compared to learners

trained in the traditional way, gain a lot of information, teamwork, cooperation, respect for group members, curiosity and patience, in addition to deep learning skills such as interpersonal communication, critical thinking, decision-making, reasoning, and resource use which will have a great impact on their future job performance (Malek Gholam, Rafqat, & Khafza, 2018).

Philipp, Ulrich, Romain, and Brunner (2013) concluded that the ability to solve a complex problem has only a slight incremental validity beyond traditional information scales. Based on these results, the value of assessing the ability to solve complex problems in the educational context is discussed and it was found that reasoning power was significantly related to different indicators of educational achievement. The results of Firooz Bakht, Foolad Chang, and Tabatabai (2015) showed that the experimental group that received problem solving training is not significantly different from the control group in terms of academic performance. Also, McGee (2003) and Krischner, Sweller and Clark (2006) stated that problem solving method has no effect on academic achievement.

According to the above studies, it is stated that metacognition training and problem solving training are active and self-regulated learning methods, which can lead to better learning and academic performance of students - especially gifted students who have relatively high intelligence and academic aptitude. They strive to learn better and more productive and succeed and compete with each other in this area. Students who strive to learn better and more useful are given the opportunity to acquire more skills for academic achievement by accelerating and deepening their learning. Focusing on problem-solving and metacognitive learning situations allows students to build their own comprehensive knowledge. Therefore, the content of lessons and teaching methods in schools for gifted students should be the best and most effective teaching methods should be acquired. Evidences show that metacognitive teaching methods and problem-based teaching strategies are among the methods that can be effective in educational environments such as schools for gifted students (Gallagher, translated by Mehdizade, 1993).

According to the theoretical background of the research, in this research we sought to answer the question of what better way can improve the strategies and components of teaching-learning. Therefore, ’comparing the effect of metacognition training and problem-solving training on teaching-learning strategies has been considered in this study to solve the learning problems of gifted students.

Method

This study is an applied study in terms of purpose and is a quasi-experimental study in terms of type and the participants were divided into three groups (one control group and two experimental groups with pre- and post-training tests).

Participants

The statistical population included all gifted high school male students in Ardabil Province in 2017-2018 (127 people in four educational classes) who entered the school through the national entrance exam. From this community, sixty students from six classes in the school were selected through simple random sampling method (suitable for experimental research based on Cohen's table) and were randomly divided into three groups, two experimental groups and one control group. The mean age of male students participated in this study was 15.4 years and the standard deviation was 1.01. These students were studying in the 10th grade at Tiz Hooshan (Gifted) School and their educational status was all above average (good and excellent).

Instruments

The LASSI (Study and Learning Strategies Questionnaire) was used in order to collect data in two stages before and after training as the pre and posttests. This informative questionnaire was designed to assess students' knowledge of the strategies used in their study and learning process. This questionnaire contains 80 questions in 10 areas including, selection of the main idea, test and information processing strategies, anxiety, attitude, motivation, time management, self-examination, study guidance and focus of learners' abilities in the field (Weinstein &Schultz, 1987). Because the questionnaire is a diagnostic tool for determining learning problems in ten distinct areas, the total score is not calculated; research subjects score 1 to 5 by marking on a five-point Likert ranking scale. Therefore, the range of scores in each field is between a minimum of 8 to a maximum of 40 (Khadi Zadeh, Seif, & Valaei, 2004). This questionnaire is a clear and understandable tool that has been used many times to assess students' attitudes and strategies in studying and learning and has been repeatedly reviewed and evaluated as a national norm (USA) based on samples from twelve different institutions in different geographical regions, including universities, state colleges, and technical institutes. Currently, 2247 educational institutions use this list. The list reliability coefficient has been calculated in the national norm in the United States.

Weinstein obtained coefficients of reliability of 0.77 to 0.89 for this questionnaire (Weinstein & Palmer, 2002).

Procedure

Before the implementation of the training programs, three groups were tested by the Teaching-Learning Strategies Questionnaire developed by Weinstein and Schultz in 1987. Then, for the first experimental group, the metacognition training program based on the Flavell model (1979) and for the second experimental group the problem solving skills program based on the model of D'zurilla and Coldfried (1971) were adopted. Each group trained in eight sessions of 120 minutes and the control group did not receive any training. After the test, the LASSI questionnaire was administered to all three groups. Data related to 20 people in the control group and 40 people in the two experimental groups were analyzed. For descriptive analysis of the data, mean and standard deviation and MANOVA test were used to determine the effectiveness of training interventions based on metacognition and problem solving training.

As mentioned before, the metacognition training program based on the Flavell model (1979) for the first experimental group and the problem solving training based on the model of D'zurilla and Coldfried (1971) for the second experimental group were held in eight 120-minute sessions according to Table 1.

Table 1.
Metacognition Training and Problem Solving Training

Sessions	Metacognition Training	Problem Solving Training
1	Motivation, expressing purpose, interacting with learners ...	Definition, importance and general role of problem solving skills....
2	Teaching practice and repetition strategies (underlining or highlighting key items, taking notes ....)	Understanding the problem and its correct representation, its relationship to behaviors and awareness of the fact that potential problems can be solved
3	Explanatory and semantic development strategies; creation of analogs, application of algorithms and previous knowledge and personal experiences….	Accurate identification and description of the problem in the form of precise and explicit words
4	Organizing strategies; coding, reminding and organizing information and networking, highlighting and ….	Teaching brainstorming methods, providing possible and impossible solutions to important problems
5	Designing, goal setting, time management and scheduling, selective attention	Discussion and practicality in using the two-column fan or fan disadvantages and advantages
6	Self-monitoring, providing techniques to control the effectiveness of learning activities	Explaining the choice of solutions with the most advantages and the least disadvantages
7	Self-assessment: Assessing the quality of learning outcomes, evaluating processes, goals and reviewing....	Explain the effectiveness of learners' executive solutions and return if the solution fails and try other solutions and finally find a suitable solution
8	Repetition and reviewing of what has been said, presentation of exercises, troubleshooting	Review of previous sessions, review and summary

Findings

Data related to determining the effectiveness of problem-based educational interventions and metacognition training in both descriptive and analytical domains are obtained as follows. The mean age of male students participating in this study was 15.4 years and its standard deviation was 1.01. These students were studying in a special school for gifted students in the tenth grade. Table 2 shows the status of subjects' scores in pre-test and post-test in 10 areas of teaching-learning strategies.

Table 2.
Subjects' Scores in Pre-Test and Post-Test in 10 Areas of Group Teaching-Learning Strategies

Method		Number		anxiety	Attitude	Focus	Data analysis	Motivation	Self evaluation	Choosing idea	Studying guide	Time management	Test strategies
Control	Pre test	20 students	SD	20.30	21.99	19.98	24.40	23.60	23.50	27.03	23.55	20.30	21.35
			Mean	7.78	7.30	7.44	7.25	6.41	5.04	4.81	5.48	5.70	4.73
	Post test	20 students	SD	21.70	21.62	18.60	25.60	22.05	20.85	26.75	21.25	19.65	22.05
			Mean	8.37	7.005	7.01	7.40	4.74	5.24	4.74	6.35	5.87	5.02
metacognition education	Pre test	20 students	SD	21.80	22.70	21.50	24.55	21.90	22.50	25.91	21.75	22.00	23.95
			Mean	5.63	5.47	5.48	5.48	5.23	5.64	6.99	4.64	5.98	6.64
	Post test	20 students	SD	29.50	33.15	30.95	30.35	29.85	29.05	32.30	28.80	30.30	32.50
			Mean	6.25	5.90	6.15	6.72	5.73	7.40	5.92	6.27	5.60	5.78
problem solving	Pre test	20 students	SD	19.60	22.68	19.45	24.30	22.50	21.50	27.45	22.00	21.15	20.60
			Mean	6.23	8.23	7.79	7.40	5.05	5.69	4.39	6.21	5.83	4.35
	Post test	20 students	SD	29.00	27.60	26.20	30.00	27.15	25.60	31.25	25.90	25.35	27.80
			Mean	6.30	7.94	8.45	5.26	5.76	6.43	4.88	5.99	6.96	6.90

Considering the research question to see if there is a difference between the effects of two methods of metacognition and problem solving education on the level of knowledge of teaching-learning strategies of gifted high school students in Ardabil, the MANOVA test was used to examine the question. Shapiro-Wilk test was used to examine the normality of learning strategies data. The results showed that the level of significance in all components of learning strategies in pre-test and post-test is greater than 0.05 and shows that the data are normal. Also, the assumptions of analysis of variance; Levin test, Box test and Wilkes lambda test were performed. The value of the box statistic is 69.449 and the significance level is greater than 0.01which shows that the data has not violated the same assumption of the variance-covariance matrix. The results of Loon test of the effectiveness of metacognitive education and problem solving in the components of teaching-learning strategies with a significance level is greater than 0.05 which shows that the variance of the dependent variable is the same among the groups and does not violate the homogeneity of variances. Moreover, Wilkes lambda test (P <0.01) showed that the effect of two educational methods on teaching-learning strategies of the students is not significantly different. Analysis of variance was used, based on these assumptions and preconditions.

Table 3.
MANOVA OF the Effect of Metacognition and Problem Solving Training on Teaching-Learning Strategies

		Total squares	Degrees of freedom	Average of squares	F	The significance level	Separate Eta squares
Group	**Data process**	2/000	1	2/000	0/666	0/888	0/111
	Choosing the main idea	1/444	1	1/444	0/888	0/777	0/000
	Test strategies	777/000	1	777/000	5/222	0/999	0/111
	Attitude	444/777	1	444/777	3/777	0/111	0/333
	Anxiety	3/0	1	3/000	0/111	0/000	0/111
	Motivation	5/000	1	5/000	0/333	0/777	0/222
	Focus on questions	211/...	1	111/000	4/111	0/555	0/777
	Self-examination questions	00/333	1	00/333	0/222	0/999	0/000
	Study guide	6/000	1	6/000	0/111	0_333	0/333

		Total squares	Degrees of freedom	Average of squares	F	The significance level	Separate Eta squares
	Time management	888/000	1	888/000	4/333	0/888	0/555
Interaction effect (regression slope) of the pretest	**Information processing**	99/000	2	44/000	0/111	0/888	0/000
	Selecting the main idea	22/222	2	66/666	0/111	0/111	0/999
	Test strategies	000/555	2	00ï888	1/999	0/999	0/888
	Attitude	999/333	2	99/...	1/999	0/222	0/888
	Anxiety	44/999	2	77/555	0/666	0/000	0/888
	Motivation	66/333	2	88/777	1/999	0/000	0/1
	Focus on questions	000/000	2	0 /555	0/555	0/777	0/666
	Self-examination questions	22/444	2	66/777	0/000	0/555	0/999
	Study guide	66/666	2	33/888	0/444	0/555	0/777
	Time management	44>111	2	77ó555	0œ	0/444	0/000
Error	**Information processing**	6666/000	66	77/555			
	Selecting the main idea	6666/000	66	11/888			
	Test strategies	8888/000	66	77/777			
	Attitude	8888000	66	44/444			
	Anxiety	6666/222	66	**/111			
	Motivation	1111/***	66	22/444			
	Focus	2222/000	66	00/888			
	Self-assessment	5555/000	66	88/555			
	Study guide	7777/...	66	hh/000			
	Time management	5555/000	66	77/888			

MANOVA analysis of variance test was used to compare the effect of two types of metacognition and problem solving training on the components of teaching-learning strategies in the gifted students (Table 3). According to the results and the study of the main effect of metacognition and problem solving training on each component of teaching-learning strategies, there is a significant difference in the components of test, attitude, focus and time management strategies and the effect of metacognition training on problem solving in these components were more for gifted students; the main effect of metacognition and problem solving group on the components of information processing, main idea selection, anxiety, motivation, self-examination, study guide was not significant at the level of $P < 0.05$.

Discussion

The aim of this study was to compare the effectiveness of metacognition and problem solving training on teaching-learning strategies of gifted high school male students in Ardabil. By examining the main effect of the two types of metacognition training and problem solving, differences were observed only in the components of test strategies, attitude, focus, time management. Moreover, the results of the means show that the effect of metacognition training was better than problem solving. It was also found that the main effect of metacognition and problem solving training on the components of information processing, main idea selection, anxiety, motivation, self-examination, study strategies was not significant.

Regarding the effectiveness of metacognition training on learning strategies, this finding is consistent with the findings of Panadro (2017), Emily et al. (2017), Swanson (2015), Rahimi and Shojaeizadeh (2018), Tolara et al. (2016), Cornoldi et al. (2015), Shaykh oleslam et al. (2013). This consistency indicates that teaching metacognitive strategies, the field of scientific involvement, the source of internal control, positive documents, motivation for further development, creativity and constructiveness and self-responsibility in people and a sense of self-confidence in life strengthen and enable people to identify problems and test their activities, act freely and independently and offer the best solutions in various matters (Mahboubi & Mostafaei, 2006). These findings are also inconsistent with the findings of Masoumi (2007) and Quixin (2012); which can be due to the use of different assessment tools and different statistical samples (students). Also, the effectiveness of problem solving on teaching-learning is consistent with the findings of Malek Gholam et al. (2018), Molnar and Csapo (2018), Lao (2014), Daresh et al. (2018) and are not consistent with findings of Farnsworth (1994), Kirchner et al. (2006), and Firoozbakht et al. (2015) which may be due to the use of different measuring tools. Farnsworth (1994) considers this method to be inefficient. Weber believed that solving complex problems without prior knowledge and without the help of the teacher imposes a heavy workload on students and at the same time is not efficient enough. In addition, the responsibility and independence that students have to experience in this way can be stressful and confusing for them. The learner has to acquire extensive information and knowledge without the help of the teacher, which is very costly and time consuming. Kirchner et al. (2009) claimed that this method is ineffective because the approach of receiving minimal guidance from the teacher is not compatible with human cognitive structure.

In explaining the study questions, it can be said that both metacognition and problem solving methods are effective on gifted students' learning strategies and the reason for the lack of differences between these two methods in some of the components might be related to the fact that gifted students have some optimal attention and motivation in information processing. Their processing speed is better and higher, and as a result, they perform better in metacognition training and problem solving. Cognitive learning (both metacognitive and problem-solving training) increases the creativity and talents of gifted students in applying learning techniques and methods. The reason why the difference between the effectiveness of two types of metacognition and problem solving training on some components of gifted students' learning-teaching strategies has not been significant is that both metacognition and problem solving methods point that any change in students' metacognitive knowledge will affect their ability to solve problems (Salaryfar, 2010). However, due to the great variety in problem solving methods, the average scores of metacognition training components were better than the problem solving method.

Conclusions

Metacognition includes executive control processes (such as attention, review and practice, organizing and manipulating information), and these processes cause a pervasive difference in learning and recalling, so that the stronger these processes are in students, the better the process of concentration in their memory. Metacognitive strategies make a person have a more complete management and control over their time and performance according to the nature of tasks. Although both methods are cognitive methods, the mechanisms of self-monitoring and individual and time management are more in metacognition (Paris & Vinigrade, 2010). Therefore, these strategies, due to facilitating successful experiences and creating the necessary opportunities for practice, may promote creativity and help select the main idea, achieve academic performance and successful learning experience for gifted students (Farrokhi, 2010) and increase the effectiveness of the components of test strategies, attitudes, focus, and time management in educating the metacognition.

Furthermore, since the problem-solving method requires being in a problem-solving situation and some practical conflicts, and the focus is less than metacognition training on this issue, test strategies are different and require more time to conclude. This conflict reduces the focus on the task and attention; it takes students away from the task at hand. The results of Wayne et al. (2017) showed that problem-solving learners use more deep processing, self-regulation, and external regulation than their peers. However, these learners often rely on external resources to adjust learning strategies; like teachers, who rely on teaching materials and assessment. Students, on the other hand, need a lot more time in the beginning to master this method and improve their skills in this field. The longer students are trained by this method, the more success they will gain. The variety and methods of problem solving are very large, varied and time consuming depending on the type, while in metacognition training, the total involvement with the learning and teaching process is taught and the monitoring, evaluation and control of individual learning are discussed. Metacognition mechanisms eliminates the need for extra

search to find the solution to the problem and leads to a path that makes it possible to reach the correct answer in a limited time with more motivation. Despite the fact that gifted students have high metacognitive knowledge, they have performed worse in problem solving. According to Gholami et al. (2016), problem solving is an individual skill and therefore varies from person to person and from situation to situation, and there is no general rule for dealing with the problem.

This study faced some limitations. Since the research findings were based on scale and the use of questionnaires, and questionnaires are prone to distortion due to unconscious findings, and this may threaten the research results. Also, this study was conducted only on gifted male students of 10th grade in Ardabil, the results can be generalized for male students; therefore, extending the results to other areas and cities should happen with great caution and care.

Due to the effectiveness of metacognitive education, it is recommended that psychologists and counselors use and recommend this technique in schools to strengthen the use of students' teaching-learning strategies.

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