

Investigation of the utilization amount of the metacognitive strategies

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Abstract

The aim of the present research is investigating the application of metacognitive strategies by the high school students in mathematics major in Isfahan, Iran in academic year of 2012-2013. The methodology of this descriptive research was of measurement type, and data collection tool was Dawson & Mackinder's Questionnaire (2004). The validity of this study was confirmed by the experts of the field. Its reliability was calculated as 0.81 using Alpha- Chronbach Coefficient. Making use of Cochran's formula, the sample volume was a number of 369 students, who were selected using the Cluster Random Sampling & Stratified Random Sampling, and the selection was proportional to the volume.

To analyze the data, both the descriptive & inferential statistics were used. The results of this study showed that the amount of application of meta-cognitive strategies (planning strategy, control & supervision strategy, regulation strategy) by the high school mathematics students was above average and there was a significant difference between the score collections of the metacognitive strategies in their different dimensions.

Keywords: metacognitive strategies, Planning strategies, control & supervision strategies, regulation strategies, high school period

1. Introduction

The progressive movement of science is undeniable, and this movement is much faster and faster day by day. In such progressive movement, the modern ideas are rapidly getting old, and the new opinions replace with the newer ones while they are susceptible to getting old themselves (Quing, 2012). Regarding the vast range of the new information, the illiterate people in the 21st century are not those who are not capable of reading and writing, indeed, are those ones who cannot learn anything and also cannot store what they have learned in their minds and learn new subjects more easily and rapidly by using their previously-learned information appropriately (Lagha Reiss Danna, 2010).

Abedi (2011) believes that the main problem of those students, having trouble in learning is that they have never learned how to learn. Learning how to learn is one of the main goals of the Education in the 21st century, since, in this meta-complicated age, the individuals face the problematic situations who cannot resolve them using the previously-learned responses. Learning to learn is called Meta-cognition in the field of learning psychology.

One of the first definitions of understanding meta-cognition originates from Flavell. He held the view that meta-cognition is a matter that regulates the learning process and includes the permanent reassessment as well as the regulation of the cognitive process in order to achieve cognitive goals. Meta-cognition is an advanced thinking; thinking about thinking and learning to learn. This view that "the learners think about their thoughts" dates back to Plato and Aristotle's ages (Niaz Azari, 2004).

Moses & Baird (2002) **believed** meta-cognition is known as a general aspect of cognition, including all cognitive information. This concept consists of those knowledge (beliefs), processes and strategies that evaluate, supervise or control the cognition.

Metacognitive ability and development commence from the mid-childhood, i.e., the pre-operational period and have an arduous and slow development that necessitate the development of some cognitive pre-requisites such as dominance on the symbols, **destruction** of egocentrism, language development, etc (Abedi, 2011). The factors affecting the meta-cognition change are as follow: the cultural factors & cultural learning's, personal organization & interaction with the fellow individuals of the same age (Mohseni, 2006). The development of meta-cognition in the study schedules means that, in effective teaching & learning, the study schedules help the students to perceive and discover the concepts themselves and finally guide them towards "meta-cognition" (Farrokhmehr, 2010).

The students who enjoy a high meta-cognition power can possess a regular learning process, i.e., they can choose those strategies, compatible with their assignments and their learning styles. The learning will be surely simplified and improved and the results of higher quality will be gained if the meta-cognitive learning strategies are effectively utilized (Zahedi & Dorimanesh, 2009). Aydin (2010) believed that the individuals' cognition and their meta-cognitive system are one of the most effective factors in learning and doing affairs, insofar as the extent that the difference in the individuals' learning quality and speed is because of the difference in their meta-cognition (Lotfabadi, 2011).

Meta-cognitive strategies exert cognition on the cognitive strategies and also direct them. Effective use of cognitive strategies necessitates use of meta-cognitive learning strategies (Zahedi & Dorimanesh, 2009). The meta-cognitive strategies are of very high importance, since they are frequently used in teaching several subjects and they meet the learning needs (Aghazadeh, 2012).

The essential meta-cognitive strategies in this study are as follow: planning strategies, control and supervision & regulation strategies.

Planning strategies:

Planning necessitates determining the goal of study, for instance, in a brief study of the topics, there can be some questions based on which the learners can determine how they should do the assignments. Moreover, planning involves selection of suitable strategies and arrangement of those sources affecting the learners' performances. Regarding this, Schraw & Moshman (1995) say: "For instance, before beginning to study, the individuals make some predictions, consider some strategies, estimate the time needed for studying and pay their selective attention to the study itself. Planning for learning is similar to the method that a sport coach applies to substitute a player against the rival team. Having watched the movies of the rival team, he decides on the strategies for attack, defense & confrontation. Then, the coach talks to the players to let them know their responsibilities in the match. Seemingly, the students should have a general design for learning: they take notes while studying and attending the classes, predict the time needed for studying, review their notes & organize the study groups, in case needed. Also, they apply some other types of self-regulatory behaviors and, if necessary, they refer to the sources other than their course books. Dembo (1994) believes that the learners are completely active, not passive (Cadivar, 2012).

Concerning the importance of these meta-cognitive strategies, Seif (2010) stated that the successful students are not those who only attend a class, listen to the lessons, take notes and wait for the teacher to determine the exam dates; But, the successful students are those who predict the time needed for doing the assignments, get the needed information for conducting researches, form the working groups if needed, and make a frequent use of other self-regulatory or **self-arranging** behaviors. Planning is an intentional selection of the strategies in order to achieve the special goals (Shaabani, 2013).

The planning strategies include determining the goal of study and learning, predicting the needed time for studying, determining the suitable speed for studying analyzing how to encounter the matter of learning & selecting useful learning strategies.

Control and supervision strategies

By control and supervision strategies, it is meant that the learners have conscious supervision on their works in order to know about how to improve in their studies. Such supervision involves supervision on the attention while reading a passage, asking oneself questions about the subjects of study while studying and examination of the time & speed of study. These strategies help the learners to rapidly recognize and problems they may encounter and make an attempt to solve them (Seif, 2010). The skill of meta-cognitive caring means that the learners continually take care of their work, asking themselves "What should I do now?", "Is what I am doing now right?", "Is my speed for studying enough?" & "Have I learned enough subjects?" (Lotfabadi, 2011).

Dembo (1994) stated that the learners may ask themselves question about the subject matters to be in their exams at the time of studying or getting prepared for the exams, and discover that they have not well understood some parts of the lessons or their study and note-taking methods were not effective for some parts of the books. In this case, they may decide to apply another strategy. Such a decision is based on the application of the supervision strategy in learning. Moreover, the students' prediction of the sample questions they may encounter in the exams

leads to their better learning more attention to the subject matters. Such a deed, as one of the strategies of control and supervision, can help the learners in their effectively getting prepared with their exams (Abedi, 2011).

Through predicting several types of sample questions, most students recognize that what parts are important. This skill shows improvement of the students' attention to the subject matters. The teachers can let the students know about what parts are of lower importance in order for them to more effectively make use of their studying opportunities.

Knowing the information processing system is beneficial, particularly for those teachers who are facing their students' lack of attention. Thus, the successful teachers' first step is drawing the students' attention to the subject matters. They can do so by helping them in their selecting the important matters: motivate them to pay attention to the subject matters, reduce their distraction & teach them some skills in order to focus their attention to learning and the learning situation. Gaining meta-cognitive control over learning enables the students to understand the reading passages and respond to them personally and critically (Aghazadeh & Ahadian,1999). Control and supervision strategies involve evaluation of achievement, supervision on attention, question-making while studying & learning, time management and speed of study.

Regulation strategies

Regulation strategies or ordering or arrangement leads in flexibility in the learners' behaviors and help them to change their learning styles at anytime needed. Dembo(1994) stated that one of the features of successful learners is their ability to modify their ineffective cognitive strategies or to replace them with the effective ones(Abedi,2011). In other words, Regulation strategies are the quality of the learners' judges about the processes and results of thinking and learning. In this case, they continually ask themselves "Should I change my strategies?", "Am I in need of help?" & "Is everything right?" (Lotfabadi, 2011)

Brown (1978) believes that arrangement is examining how to achieve the ultimate as well as secondary goals and that lack of this stage shows a blind execution of the functions. From this perspective, arrangement is considered as a continual evaluation of how to reach the ultimate as well as secondary goals; for instance, by asking oneself such a question as "Have I stepped towards my goals or I have deviated from them?" after this stage, the execution of reassessment in a critical manner is explored (Shaabani,2013).

The regulation stage is a step of showing the mental activities related to self-evaluation, both the mental as well as practical activities. The mental activities involve finding solutions, adopting a working style, forming a particular attitude towards the subject & examining the pre-requisites. The practical activities include practice and review to make the information meaningful (Aghazadeh, 2012).

Schraw & Moshman(1995) believed that regulation strategy is in correlation with the control and supervision strategies. For example, when the learners fail to understand a portion of a passage and cannot answer the questions related to it, they will review the previous parts. In such conditions, their speed decreases due to the difficulty of the subject or their unfamiliarity with it. Thus, the arrangement strategy helps the learners to modify their study qualities, to review again and to remove the deficits in their understandings (Kadivar, 2012). As an element of meta-cognition, the regulation strategies involve adjustment of study speed as well as modification of or change in the cognitive strategies.

Meta-cognitive strategies cannot be improved by one or two experiences, while they should be as a part of permanent programs, together with specialized training, regarding them(Zahedi & Dorimanesh, 2009). These strategies are of so much importance that such researchers as Parviz & Sharifi(2012), in their study, stated that most of the students, using cognitive strategies face several troubles in learning the subject matters, while those, placing more emphasis on meta-cognitive strategies have achieved a higher academic achievement.

There have been some researches which have examined the amount of application of such strategies; among which, a research conducted by AbdulRahim (2010) reached the result that the students of Basic sciences in Malaysia apply a mediocre level of meta-cognitive strategies to their lessons. In their studies, Juibari & Hanifi (2013) found that the application of meta-cognitive elements is above average from the science staff members' perspectives, and such an amount has been considered weak by them. HasanZadeh & Mo'tamedi Telavaki (2013) found that the teachers' skills in application of the teaching patterns(on the basis of Structuralism) significantly influence the meta-cognitive strategies. In their study, they introduced the highest improvement for planning strategies and the lowest improvement for the regulation strategies. Seif (2013) believed that an

increase in the application of meta-cognitive strategies leads in an increase in the amount of creativity. In another research, FeiziPour & Zeinalli(2013) found that teaching study and learning strategies(meta-cognitive strategies) positively influence the prevention of **academic decline** among the university students. The meta-cognitive strategies are important since the students will be capable of solving their problems independently and without their teachers if they get familiar with the meta-cognitive strategies. Those students who can or want to take the major responsibility of regulating their own learning qualities possess the best opportunity to achieve success in a world which is under fast changes in technologies and severe social alterations (AghaZadeh & Ahadian, 1999). Any individuals, who want to participate in this era, i.e. the era of science dominance, need to absorb the new ideas, perceive the modern designs and resolve the non-traditional issues. Mathematics is an appropriate key to the preparation for such participations (AzzetKhah,2004), while the TIMS results in Iran during the several years have shown that the Iranian students' performances in mathematics have been on the decrease or have not had a considerable increase, and that their average score has been under the international average (Karimi et al, 2010; Karimi, 2011). In this regard, an analysis of the TIMS results on those countries which enjoy the higher ranking in the world TIMS, e.g. Singapore shows that their major goal of their school curriculum has been solving the issues, related to mathematics. Also, Kaur (2012) stated that concept learning, learning mathematical skills, use of thinking & self-regulatory skills in learning or meta-cognition and problem-solving strategies are focused on.

The application of meta-cognitive strategies in learning mathematics is also of importance and some researchers have conducted some studies regarding it. In a research, Cai(1992) found that gaining achievement in mathematics highly needs one to be aware of the different mathematical strategies and to apply them. Panaoura & Philippou (2007) believed that the meta-cognitive strategies are goal-oriented, are consciously motivated & increase the students' efforts. Regarding the relationship between meta-cognition and mathematical problem-solving, Ayat & Tarmizi(2010) concluded that there was an average and positive correlation between the meta-cognitive strategies and Algebra problem-solving performance among the university students. In their studies, Muhammadi AhmadAbadi et al.(2013) examined the effects of the meta-cognitive strategies on the mathematical problem-solving and concluded that the meta-cognition teaching exerts a positive influence on the students' capability of problem-solving and encourages them to learn mathematics. YarMuhammadian & Asli Azad (2013) concluded that 67% of the variance of academic performance in mathematics was thanks to intervention of meta-cognition teaching.

With regard to the theoretical background and the research literature, in general, it can be said that the application of meta-cognitive strategies for learning mathematics is essential. Thus, the present research was conducted regarding the above-mentioned concerns and, also some questions were proposed for it.

2. The Research Questions

1. To what extent did the third grade high school students of mathematics apply the planning strategies?
2. To what extent did the third grade high school students of mathematics apply the control & supervision strategies?
3. To what extent did the third grade high school students of mathematics apply the regulation strategies?
4. Is there any significant relationship between the applications of the meta-cognitive strategies with regard to the demographic factors?

3. The Research Methodology

The present research was of descriptive measurement type. The descriptive research which has been conducted to analyze the relationships between the non-manipulated variables and the generalization of the results were centralized and the accumulated results could be expanded and generalized to other cases outside the observed samples in this research. The statistical population of this study involved all the third grade high school students of mathematics, studying an academic year of 2012-2013 in Isfahan, Iran, and they were a number of 7366 students. Making use of Cochran's formula, the sample volume was a number of 369 students, who were selected using the Cluster Random Sampling & Stratified Random Sampling, and the selection was proportional to the volume. The tool, used in this research was Dawson & Mackinder's Questionnaire of meta-cognitive strategies. This questionnaire included 18 questions as well as the three elements of planning, control & supervision and regulation, and the reliability of this test was reported by them 0.75-0.78, making use of Alpha-Cronbach Coefficient. Also, Bolouk (2011) normalized this questionnaire, and using Alpha-Cronbach Coefficient, reported its reliability 0.88 (the reliability indices of planning, control & supervision and regulation were 0.74, 0.79 & 0.8, respectively). In general, Bolouk showed that Dawson & Mackinder's Questionnaire was

a suitable & multi-dimensional tool for the assessment of meta-cognitive strategies. Moreover, Sabbaghan(2012) calculated the reliability of the questionnaire as 0.88, using Alpha-Cronbach Coefficient. Its external validity was confirmed by the specialists in this field. In order to achieve the reliability of this tool for the present research, an introductory study was conducted on a number of 30 students, and the Alpha-Cronbach Coefficient was 0.81. The collected data was analyzed using SPSS-19 software, and the results were presented in the two parts of Descriptive & Inferential Statistics. Regarding Descriptive statistics, frequency, ratio frequency percentage, mean & Standard Deviation were used. Concerning Inferential Statistics, mono- variate t-test, Friddman’s test, analysis of multi-way variance & least Significant Difference test were utilized.

4. Research Findings

The collected data for the application of the strategies were shown in Table 1.

Table 1:comparison of the mean score of application of the strategies by the third grade high school students of mathematics with an assumed mean of 3.

Element	Mean	Standard Deviation	Deviation from mean	t	Degree of freedom	Level of Significance
Meta-cognitive strategies	3.59	0.51	0.027	21.442	350	0.001
Planning strategies	3.42	0.66	0.034	12.028	360	0.001
Control & Supervision strategies	3.82	0.68	0.036	22.818	361	0.001
Regulation strategies	3.54	0.71	0.037	14.466	362	0.001

Based on the findings of Table 1, of the mean score of application of the meta-cognitive strategies by the third grade high school students of mathematics was 3.59. the calculated t was higher than the amount of t in the table. Thus, the score of application of the meta-cognitive strategies by the third grade high school students of mathematics was above the average.

Question number 1: To what extent did the third grade high school students of mathematics apply the planning strategies?

Table 2:comparison of the mean score of application of the planning strategies by the third grade high school students of mathematics with an assumed mean of 3.

Element	Mean	Standard Deviation	Deviation from mean	t	Degree of freedom	Level of Significance
Planning strategies	3.42	0.66	0.034	12.028	360	0.001

Based on the findings Table 2, the mean score of application of the planning strategies by the third grade high school students of mathematics was 3.42. The calculated t was higher than the amount of t in the table. Thus, the score of application of the planning strategies by the third grade high school students of mathematics was above the average.

Question number 2: To what extent did the third grade high school students of mathematics apply the control & supervision strategies?

Table 3: comparison of the mean score of application of the control & supervision strategies by the third grade high school students of mathematics with an assumed mean of 3.

Element	Mean	Standard Deviation	Deviation from mean	t	Degree of freedom	Level of Significance
Control & Supervision strategies	3.82	0.68	0.036	22.818	361	0.001

Regarding the findings of Table 3, the mean score of application of the control & supervision strategies by the third grade high school students of mathematics was 3.82. The calculated t was higher than the amount of t in the table. Thus, the score of application of the control & supervision strategies by the third grade high school students of mathematics was above the average.

Question Number 3: To what extent did the third grade high school students of mathematics apply the regulation strategies?

Table 4: comparison of the mean score of application of the regulation strategies by the third grade high school students of mathematics with an assumed mean of 3.

Element	Mean	Standard Deviation	Deviation from mean	t	Degree of freedom	Level of Significance
Regulation strategies	3.54	0.71	0.037	14.466	362	0.001

Regarding the findings of Table 4, the mean score of application of the regulation strategies by the third grade high school students of mathematics was 3.54. The calculated t was higher than the amount of t in the table. Thus, the score of application of the regulation strategies by the third grade high school students of mathematics was above the average.

In order to determine whether the application of meta-cognitive strategies in the different above-mentioned dimensions was the same or not and to rank the elements, the Friddman's Test was used.

Table 5: mean of the ranking of meta-cognitive strategies

Elements	Mean of ranking
Planning strategies	1.73
Control & Supervision strategies	2.42
Regulation strategies	1.85

The findings of Table 5(mean of the ranking of the dimensions) showed that the control & supervision strategies and the planning strategies possess the highest & lowest ranks, respectively.

Table 6: **Friddman's Test**

Number	351
Amount of Chi square	101.026
Degree of freedom	2
Level of Significance	0.001

The results of Table 6 showed that the results of the ranking collections of the meta-cognitive strategies in different dimensions were significant at the level of $p < 0.01$ (the amount of Chi square 101.026). Thus, the research question "Is there any significant relationship between the score collections of meta-cognitive strategies in different dimensions?" was confirmed.

Question Number 4: Is there any significant relationship between the applications of the meta-cognitive strategies with regard to the demographic factors?

Table 7: analysis of multi-way Variance of the scores of meta-cognitive strategies with regard to the demographic characteristics (gender, the location of school, type of high school, average & the parents' educational level)

Source	Sum of squares	Degree of freedom	Square Mean	F	Level of Significance
Gender	0.254	1	0.254	1.003	0.317
School location	0.285	2	0.142	0.563	0.570
Type of school	0.747	2	0.373	1.476	0.230
Average	1.695	3	0.565	2.835	0.038
Father's educational level	1.076	4	0.269	1.350	0.251
Mother's educational level	3.048	4	0.762	3.824	0.005

The results of Table 7 showed that there was not any significant difference between the respondents' views regarding the meta-cognitive strategies based on gender, location of school, type of high school & the father's educational level; but there was a significant difference between the respondents' views regarding the meta-cognitive strategies based on average & the mother's educational level. In order to determine which groups such differences were in favor of, the Least Significant difference test was used.

Table 8: the Paired t-test for comparison of mean of meta-cognitive strategies based on average

Average	Difference from mean	Level of Significance
12-14(3.25) → 16-18(3.57)	-0.31	0.046
12-14(3.25) → above 18(3.66)	-0.41	0.007
14-16(3.46) → above 18(3.66)	-0.21	0.003

The results of Table 8 showed that there was a significant difference between the meta-cognitive strategies among the students with an average of 12-14 and those, having an average of 16-18 & beyond. Also, there was a significant difference between the meta-cognitive strategies among the students with an average of 14-16 and those, having an average of higher than 18.

Table 9: the couple Test for comparison of mean of meta-cognitive strategies based on the mother's educational level

Mother's educational level	Difference from mean	Level of significance
Under diploma(3.67) → Bachelor's degree(3.33)	0.34	0.001
Diploma(3.61) → Bachelor's degree(3.33)	0.28	0.001
Associate degree(3.70) → Bachelor's degree(3.33)	0.37	0.001
Bachelor's degree (3.33) → Master's degree(3.68)	-0.35	0.002

The results of Table 9 showed that there was a significant difference between the meta-cognitive strategies among the students with mothers, holding Bachelor's degree. on one hand, and those students with mothers, holding diploma, associate degree, Master's degree. and even the mothers with under diploma education.

5. Discussion

The goal of this study was analyzing the amount of the application of meta-cognitive strategies by the third grade high school students of mathematics in Isfahan. The findings showed that the amount of the application of meta-cognitive strategies was above average. There was a significant relationship between the average (educational status) and the amount of the application of meta-cognitive strategies. Moreover, there was a significant correlation between the education level of the students' mothers and the amount of the application of meta-cognitive strategies.

Those results related to the first research question stated that the amount of the application of planning strategies was above average. Since planning and designing are some of the most important variables of the meta-cognitive strategies, and they are also most capable of predicting the academic achievement, the optimum and frequent application of the planning strategies can prevent the educational decline from taking place. The results of the present study were congruent with those of the studies conducted by AbulRahim Hamdan (2010) & Juibari & Hanifi (2013).

Those results related to the second research question stated that the amount of the application of control & supervision strategies was above average. The process of supervision represents a need for the arrangement processes in order to change behaviors to reach the goals or approach them. Thus, the control & supervision strategies are profound learning strategies; in such a way that its utilization leads to more successful learning and such a performance originates from the students' motivation and interest in learning. This result was congruent with the results of the studies done by AbulRahim Hamdan (2010) & Juibari & Hanifi (2013).

Those results related to the third research question stated that the amount of the application of regulation strategies was above average. These results were congruent with those of the studies done by AbulRahim

Hamdan (2010) & Juibari & Hanifi (2013). In clarifying this question, it can be said that application of the regulation strategies is one of the features of successful learners since it is their ability to modify their ineffective cognitive strategies or to replace them with the effective ones. The learners with the regulation strategies are no longer willing to continue the application of the unsuccessful learning and studying methods, always recognize the deficits and shortages of the learning methods & strategies through supervision of their own works, and also modify or replace them with the effective strategies.

Those results related to the fourth research question stated that there was a significant relationship between the amount of the application of meta-cognitive strategies and the learners' educational performances. Thus, it can be said that success at school may depend on using the effective strategies, and that the powerful students may fail in their studies due to being unaware of the effective strategies related to their schooling works; such students rely on insufficient and unsuitable strategies or are incapable of the effective strategies. On the other hand, the weak students may succeed in their studies since they have learned to make use of the cognitive & meta-cognitive strategies. Thus, in general, an increase in the amount of the students' use of the meta-cognitive strategies leads to the improvement of their educational performances.

The application of meta-cognition causes to enhance the students' capability in problem-solving, to encourage them to learn mathematics and exerts a considerable influence on reduction of the time needed for solving the difficult problems and on the students' more thorough performances.

There was a significant positive correlation between the educational level of the students' mothers and the amount of the application of meta-cognitive strategies; i.e., the higher the educational level of the students' mothers was, the more the amount of the application of meta-cognitive strategies will be.

It is suggested that some researches be conducted in order to create strategies for making the students interested and active in the application of the meta-cognitive strategies, and pathology of the students' not using meta-cognitive strategies.

With regard to the results of the present research, only limited to the third grade high school students of mathematics, studying in academic year of 2012-2013 in Isfahan, some care has to be taken in the generalization of the results to the students of other majors, education periods, cities & academic years.

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