Educational Research (ISSN: 2141-5161) Vol. 3(11) pp. 844-850, November, 2012
Available online@ http://www.interesjournals.org/ER

Full Length Research Paper

Investigation the effect of emotional intelligence skills and metacognitive capabilities on student's mathematical problem solving

[1*]Majeed Sharei, [2]Farhad Kazemi, [3]Morteza Jafari

[1]Departement of Mathematics, Iranshahr Branch, Islamic Azad University, Iranshahr, Iran
[2]Departement of Mathematics, Ghorveh Branch, Islamic Azad University, Kurdistan, Iran, and Members of Young Researchers Club, Iran
[3]Teacher in High School of Iranshahr, Iran

Abstract

Nowadays, the role of emotional intelligence and metacognitive capabilities, as the most important and effective parameters in many ranges of science and life, is emphasized by researchers. The main purpose of this study is to investigate of the relationship between emotional intelligence and metacognitive capabilities with the ability of mathematical problem solving in the students. The statistical sample in this research includes 54 female and 60 male students who were chosen randomly from the Iranshahr high schools in Iran. The Bar-On and Panaoura et.al scales are used in order to assess the emotional intelligence and metacognitive capabilities of the students. The results showed that, there is a significant relationship between the general scores of metacognitive capabilities and emotional intelligence skills, and some of their components with mathematical problem solving ability. Regarding gender specificity of the students, the findings represent meaningful difference between males and females in three variables; in fact, the performance of male students was better than females in metacognitve capabilities and problem solving, but the score of female students was higher than males in emotional intelligence skills. Also the results of a multiple regression analysis showed that metacognition and emotional intelligence contribute significantly to the prediction of problem-solving ability. However, metacognition is a stronger predictor than emotional intelligence.The results of this study reveal that, national education system of any country must consider a specific and noticeable position to develop learners non-cognitive variables, such as metacognitive capabilities and emotional intelligence skills at all educational levels.

Keywords: Emotional Intelligence Skills, Metacognitive Capabilities, Mathematical Problem Solving, Gender.

INTRODUCTION

Mathematics, before being introduced as a subject, is a way of thinking that is shaped based on the ability to understand situations and problems, explaining concepts underlying the issue, organizing and categorizing information and explaining how the problem is solved. The ultimate end of education, not only in the Mathematics but also in other sciences is to help learners to solve the problems which can be discussed in that special field of study. Ganieh (1985) considers the problem solving as the highest form of learning and defines it in this way: “problem solving is a kind of process that the learner by utilizing it can discover a new combination of what he had learned previously in order to find a way to solve a new problem”. In addition, he believes that applying the rule of problem solving is not just techniques, skills and concepts learned previously by knowledge and experience of the person in a new position; it is also a process that will lead to new learning. Some argue that the essence of mathematics

*Corresponding Author E-mail: Baten_2921@yahoo.com, majid.sharee@gmail.com

is problem solving; while others consider Mathematics as a set of tools for thinking which is available for the learner in the active process of problem solving. This process of conflict is a creative work to achieve specific objectives based on finding out new ways out of the combination of existing rules. The insight is thus obtained (cited in (Alamolhodayee, 2009, pp.183). Cock Craft (1982) considers problem solving as the ability to use mathematics in different situations and believes that students cannot begin to solve a mathematical problem, unless the problem is converted to the appropriate terms. On the other hand, some authors such as Beck House and et.al (1992) consider problem solving as an activity and not the ability to know and understand the nature of a problem situation in which the person does not know how to reach his aim. A number of psychologists consider cognitive problem-solving as a process in which a given situation transforms to a good position, while the problem solving person offers no clear way to solve it. This definition includes a few fundamental categories that include:

- Problem solving is a Cognitive process; i.e. it occurs inside the mind or cognitive system and its existence can be perceived only by mathematical and general behavior of the learner.
- Problem solving is a process, which involves manipulation of information in the cognitive or mental system of problem solver.
- Problem solving is a thinking-oriented process versus a way of thinking which has no direction or purpose.
- Comprehension of data and aims of a mathematical question and having ability to create a relationship between them is a good clue to solve the problem.
- Problem solving is a personal issue; i.e. the difficulty of converting a given state to a clear and ideal one depends on the individual's knowledge and experience.

According to researchers, the ability to solve problems is not dependent only on cognitive abilities and other factors such as metacognitive capabilities (Schoenfeld, 1985; Kazemi et al, 2010; Lucangly & Cornuldi ,1997), attitudes (McLeod, 1992; Topia, 2003, Aiken, 1979) and intelligence emotional (Guilford & Mersman, 2008; Nelson & Low, 2003; Bakhshi sorshejani, 2009) influence the success of learners.

Today, the effect of emotional intelligence as a relatively new construct of psychology, on academic achievement, social skills, career, marriage and personal life has been proved. The Emotional intelligence is a construct which was begun by asking why some people are more successful than others in life by Bar-On in 1980. Until now, different definitions of emotional intelligence are presented, which can be inferred from two theoretical perspectives:

a. The first view defines emotional intelligence as a kind of intelligence that includes excitement and emotion.

b. The second view is a combination of emotional intelligence and motivation, such as diagnostic capabilities combined with other offers.

First view of the theorists, "Mayer & Saloy" and the second view of the theorists" Gelman & Bar-on " named. Mayer and Saloy (1997), pointed out that Emotional Intelligence, the capacity to receive, understand, regulate emotions and use it in thought and behavior are defined. Bar-On (2000) included a bunch of emotional intelligence skills, talents, and noncognitive abilities that increases the person's ability to successfully cope with environmental pressures and necessities. Bar-On (1997) presented a model of emotional intelligence which has five main variable and 15 sub-variables as what comes below:

1) Interpersonal skills including emotional self-awareness (recognition and understanding of their feelings), courage (emotions, thoughts and constructive manner to protect individual rights), self-regulation (awareness, understanding, acceptance and respect for oneself) boom (realize the potential of self) and independence (self-restraint, in thought and action and the relief of emotional attachment).

2) Intrapersonal skills include interpersonal relationships (awareness and understanding of others' feelings), social (effective and productive members of their social group and show your partner as well) and have empathy.

3) Adaptability: it includes problem-decoding (identifying and defining problems, creating effective strategies), the test of reality (subjective and objective assessment of the match between what is experienced) and flexibility (the emotion, thinking and behavior when changing the location and conditions).

4) Stress Management: The ability to tolerate stress (resistance to adverse events and stressful situations), impulse control (resist impulses or impulse control) are included.

5) General mood: the joy (satisfaction of life, making one-self happy and others) and optimism (see the bright side of life and maintain a positive attitude even in the face of great odds) is included(cited in Bar-On, 2006).

Emotional intelligence as a factor in regulation of cognitive problems and in designing emotional consistency and social programs for children, adolescents and young people was paid a lot of attention by many psychologists, counselors, scholars of education, mental health professionals and others who somehow deal with students. Many experts have stressed that there is a close relationship between variables of emotional intelligence and educational achievement in different ages and also among boys and girls to the point that when a variable increases or decreases, other changes occur (Saloy et al, 2001). The importance of this topic has led to equality of emotional intelligence and analytic intelligence and it might be

effective in predicting academic or educational success and people's career. Golman (1995) have stated that emotional intelligence, even more than analytical intelligence, predicts success in school and the workplace.

Metacognition is rooted from strong theoretical and empirical ideas assumptions that some of its basic theories can be found in developmental cognitive psychology. According to Peugeot's view, learners find relationship or association between aims, means, metacognitive experiences and output of learning cases and then adapt or adjust their own observation with resultant observation. Furthermore, the basic principle of the above mentioned psychology can be found in Bruner theory. He likens human mind to a machine which uses existing knowledge to reinterpreting and reorganizing new and past information (Aghazadeh, 1998). The term of metacognition was first used in 1976 by Flavell, especially in the field of memory. He defines metacognition as cognition about cognition, or in general, knowledge and control of cognition. Ever since different specialists have applied this term in various disciplines such as artificial intelligence, conception, information processing, social learning, mathematics and so on (Flavell,1976).

Brown (1987) divided meta-cognitive into two main categories: knowledge of cognition and regulation of cognition.

Knowledge of cognition is the information that is fixed, uncertain, late developing that human thinkers have as objects of consideration.

Regulation of cognition is the activities used to check and monitor learning. These activities consist of planning activities (predicting outcomes, setting time strategies, and different forms of indirect trial and error, etc…) before solving the problems; checking activities (monitoring, testing, revising and resetting one's strategies for learning) in the process of learning and controlling outcomes (assessing the outcomes of strategic actions with the criteria of effectiveness and efficiency).

One basic aspect of learning- which has also been ignored is that students have the necessary knowledge and skills to do complex tasks but they don't use them. Perhaps the reason is that students don't have motivation or confidence to use them and they do not accept that the situation demands using those skills (Hartmen, 2001a). The different meta-cognitive skills are necessary for successful solution of any complicated problem-solving task. It is clear that people, who have higher level of meta-cognitive ability, do much better in problem-solving. They do their best to find out the relationship among the facts in a problem. They may check their accuracy, take apart complex problems toward simpler steps, and may ask themselves questions, and look for answers to make their thought clear (Panaoura, et.al.2003).

Thus, since metacognitive capabilities and emotional intelligence skills have an important role on teaching-learning process, we want to investigate the relationship between these structures and mathematical problem solving ability. In this study four hypotheses are considered:

1) There is a significant relationship between students' metacognitive capabilities with their mathematical problem solving ability.
2) There is a significant relationship between students' emotional intelligence skills with their mathematical problem solving ability.
3) There is a significant relationship between students' metacognitive capabilities and emotional intelligence skills.
4) There is a significant relationship between sex and metacognitive capabilities, emotional intelligence skills and mathematical problem solving ability.

RESEARCH METHOD

As mentioned above, the main purpose of this study is to investigate of the relationship between emotional intelligence skills and metacognitive capabilities with the ability of mathematical problem solving in the high schools students. The statistical sample in this research contains 54 female and 60 male students who were chosen randomly from the Iranshahr high schools students in east of Iran. The Bar-On (1997) and Panaoura et.al (2003) scales are used in order to assess the emotional intelligence and metacognitive capabilities of the students. The Bar-On scale contains 90 statements and five sub-scales(Interpersonal skills, Intrapersonal skills, Adaptability, Stress Management, General mood) that was developed by five- choice Likert scale ranging from always, often, sometimes, rarely, to never and they are given points 5, 4, 3, 2,1 respectively. Also the scale of metacognitive capabilities measurement, that is, Panaoura, et.al (2003), contains 30 metacognitive items and three sub-scales(metacognitive knowledge, metacognitive monitoring, self regulation) designed on the basis of five-choice Likert-scale ranging from always, often, sometimes, rarely, to never and they are given points 5, 4, 3, 2,1 respectively. Furthermore, for assessment of mathematical problem solving ability of students, mathematical researcher made tests was used.

Data analysis

In Table 1, descriptive statistics of students and scores obtained from scales are presented.

As it is clear from the table 1, the mean of gained scores from the scale of emotional intelligence was 294.45, which compared with scale's mean of 313.50, is at lower levels. The mean of researcher-made mathematics test was 14.72; but the scores mean of

Table 1. Descriptive statistics of scores of problem solving test, metacognition and emotional intelligence scales

Variable	Number	Avarage	Standard deviation
Problem solving ability	114	14.72	3.13
Metacognition	114	112.79	14.91
Metacognitive knowledge	114	41.18	6.68
Metacognitive monitoring	114	37.56	6.14
Self regulation	114	33.95	5.39
Emotional inteligence	114	294.45	29.83
Self awarness	114	20.34	3.25
Happiness	114	18.93	3.76
Independence	114	17.33	3.47
Stress tolerance	114	12.49	2.64
Self dehiscence	114	20.78	3.11
Problem solving	114	20.35	2.29
Realism	114	15.76	4.10
Intrapersonal relation	114	24.13	3.28
optimism	114	19.58	3.65
self-esteem	114	19.83	2.85
Impulse control	114	15.22	3.43
Flexibility	114	18.59	3.71
Responsibility	114	23.14	3.49
Empathy	114	23.52	3.13
Assertiveness	114	24.46	2.58

Table 2. The results of Pearson correlation test between variables

Variables	Correlation	Problem solving Significance level
Metacognition	.442	.000**
Metacognitive knowledge	.37	.01*
Metacognitive monitoring	.47	.000**
Self regulation	.35	.01*
Emotional inteligence	.20	.02*
Self awarness	.21	.021*
Happiness	.16	.58
Independence	.42	.001**
Stress tolerance	.13	.67
Self dehiscence	.26	.034*
Problem solving	.11	.25
Realism	.09	.47
Intrapersonal relation	.03	.86
optimism	.24	.03*
self-esteem	.15	.27
Impulse control	.12	.23
Flexibility	.38	.004**
Responsibility	.08	.39
Empathy	.17	.27
Assertiveness	.23	.03*

** $p < 0.01$ * $p < 0.05$

metacognitive capabilities of students was 112.69, that is compared with maximum amount of scale- which is 150- is at top level. Furthermore, in among of components of metacognition, "metacognitive knowledge" has the maximum mean that is 41.18, and among emotional intelligence components, " assertiveness" has the maximum amount of 24.46.

In table 2, there is Pearson correlation test between the variables of metacognition, emotional intelligence and mathematical problem solving.

Table 3. The result of T-test for comparison of metacognition, emotional intelligence and problem solving of male and female students

variables	sex	n	avarage	Std. deviation	t	df	Significance level
Metacognition	female	54	112.55	7.19	-1.89	112	P<.05
	male	60	113.03	6.55			
Emotional intelligence	female	54	297.23	17.32	4.15	112	P<.01
	male	60	291.67	15.44			
Problem solving	female	54	14.33	4.65	-2.02	112	P<.05
	male	60	15.12	4.14			

Table 4. The results of a multiple regression analysis between variables

	B	Beta	t	F	R	R^2 Adj
constant	9.35		2.76**			
Emotional intelligence	2.43	0.19	2.55*	24.10**	0.57	0.31
metacognition	5.57	0.41	4.14**			

As it is clear from the table (2) data, there is a significant relationship between metacognition and mathematical problem solving at the level of $p < 0.01$. Additionally, there is positive and significant correlation between every three components of metacognition with mathematical problem solving. Also there is positive and significant correlation between emotional intelligence and a number of its components-such as Assertiveness, Flexibility, optimism, Self dehiscence, Independence, Self awareness- with mathematical problem solving ability. The maximum amount of correlation is in independence (0.42) and the least amount is in self-awareness (0.21). There was no significant correlation between other components of emotional intelligence and problem solving. from the results it is clear that components of emotional intelligence which have metacognitive nature, have the correlation most with the mathematical problem solving ability of students; components such as independence, flexibility, self-awareness, and self-dehiscence.

In addition, the result of Pearson correlation test signifies positive and significant correlation, 0.277, between emotional intelligence and metacognition.

As it is clear from the table (3) data, the result of T-test shows that the mean scores of mathematical problem solving and metacognitive ability of male students is more than that of female, and has significant statistical difference at the level of $p < 0.05$; but the mean scores of emotional intelligence of female is more than male and has significant difference at the level of $p < 0.01$.

The results of a multiple regression analysis, shown in Table 4, indicate a linear correlation between metacognition capabilities and emotional intelligence, and performance in mathematical problem solving (F=24.10, P<0.01). The coefficient of adjusted R^2 suggests that 31% of the variance is due to the linear and combined influence of the two independent variables(metacognition and emotional intelligence). Thus, it can be said that metacognition and emotional intelligence contribute significantly to the prediction of problem-solving ability. However, metacognition is a stronger predictor than emotional intelligebce, since its Beta coefficient has a greater value (0.41 and 0.19 respectively, both significant).

According to all these, the regression equation becomes:

Mathematical problem solving ability = 0.41(metacognition) + 0.19 (emotional intelligence)

CONCLUSION

The main purpose of this study was to investigate the effect of emotional intelligence skills and meta-cognitive capabilities on student's mathematical problem solving ability. Also the possibility of metacognition and emotional intelligence to predict problem-solving ability was examined.

Although the result showed that there is positive and significant correlation between emotional intelligence and mathematical problem solving, this correlation is poor(r=0.206). There are lots of study in realm of emotional intelligence and academic achievement but the volume of done researches in mathematical problem solving is limited. The result of this study is consistent

with other researches. Guilford and mersman (2008) pointed out that by emotional- social education to high school students, they could enhance their mathematics ability. They have also shown the effect of this kind of education on emotional growth and problem solving of the students. In fact high emotional intelligence suggests mental-social healthy, better recognition of own's feelings and emotions and those of others, proper management of own emotions and those of others, empathize with others and having better relationship with them, self-motivation, and regarding oneself as valuable and competent man and finally having optimal and positive attitude to life, can have a strong and positive correlation with academic achievement.

The results showed that there is a positive and strong correlation between metacognitive capabilities and mathematical problem solving. This results are consistent with other research(for example: Kazemi and et.al,2012, 2010; Panaoura and et.al 2003,2005; lucangli and cornoldi, 1997; schoenfeld, 1985; Gooya, 1992).

Panaoura, et.al.(2003) point out that, the different meta-cognitive skills are necessary for successful solution of any complicated problem-solving task. It is clear that people, who have higher level of meta-cognitive ability, do much better in problem-solving. They do their best to find out the relationship among the facts in a problem. They may check their accuracy, take apart complex problems toward simpler steps, and may ask themselves questions, and look for answers to make their thought clear.

The result of this study showed that the mean scores of male students in metacognition and problem solving is more than female; but in emotional intelligence, achievement of female was better than male. Although there isn't consistency among researches regarding gender and metacognition, emotional intelligence and mathematical problem solving, the results of present study is consistency with following researches: in realm of metacognition (Kazemi et.al, 2010,2012; Ciascai &Haiduc, 2011; Tan & Lasward, 2008) in mathematical problem solvin (Kazemi et.al, 2012; Amani et al 2011, Mau and Lynn,2000) and in emotional intelligence (Azghandi et.al, 2006; Bakhshi sorshejani, 2009; Dehshiri, 2003).

Also the results of a multiple regression analysis showed that metacognition and emotional intelligence contribute significantly to the prediction of problem-solving ability. However, metacognition is a stronger predictor than emotional intelligence.

ACKNOWLEDGMENT

This paper has been selected from a research project, with the same title, in the Iranshahr branch, Islamic Azad University, Iranshahr, Iran.

REFERENCES

Aghazadeh M, Ahadian M (1998). *Theoretical framework and pedago-pedagogical applications of metacognition*. Noorpardazan press, winter 1998.

Aiken L (1979). Attitues toward mathematics and science in Iraninan middle schools. *School Science and Mathematics*, 79, 229- 234.

Alamolhodaee H (2009) principles of mathematics education. *Publishers of future world. First print, Iran*.

Amani A Alamolhodaei, H Radmehr F (2011) A gender study on predictive factors of mathematical performance of University students. *Educational Research journal. Vol. 2(6) pp. 1179-1192 .*

Backhouse J, Haggarty h, pirie S, Stratton J (1992). Imroving the learning of mathematics. *London: Cassell.*

Bakhshi SL (2009), the relationship emotional intelligence with mental health and achievement of male and female students in Azad university.*The journal of knowledge and research in education, no.19.*

Bar-On R (2000). Emotional and social Intelligence insights from the emotional quotient inventory (EQ-i): In.R.Bar-on & J.D. A. Parker(Ed.s).*handbook of emotional intelligence.* Sanfrancisco: Jossey- Bass.

Bar-on R (2006). The bar-on model of emotional intelligence skills development traning , program and student achievement and retention. Unpublished raw data , texas A & M university-kingsville Bar-On, R. (1997). *The Emotional Quotient Inventory (EQ-i): a test of emotional intelligence.* Toronto: Multi-Health Systems.

Brown A (1987). Metacognition, excutive control, self-regulation and other more mysterious mechanisms. In Frann Weinert & Rainer Kluwe (Eds), metacognition, *motivation and understanding (65-115). London: LEA*.

Ciascai L, Haiduc L (2011). Gender differences in metacognitive skills. A study of the 8th grade pupils in Romania. *Procedia - Social and Behavioral Sciences 29 (2011) 396 – 401.*

Cockcroft WH (1982). Mathematics count. London: *Her Majesty's Stationary Office.*

Dehshiri GR (2003) The Normalization of Bar-on scale on university students. *The unpublished thesis in Alame Tabatabae university.*

Flavell JH (1976), "Metacognitive Aspects of Problem Solving", In L. B. Resnick (Ed), *The Nature of Intelligence,* Hillsdale, NJ: Erlbaum.

Goleman D (1995) *"Emotional Intelligence", Bantam Books, N.Y.*

Gooya Z (1992), Influences of Metacognition-Based Teaching and Teaching Via Problem solving on student's beliefs about Mathematics and Mathematical problem Solving, *the university of british Columbia.*

Guilford K, Mersman J (2008). Emotional social Learning, Macgraw hill company.

Hartman HJ (2001a). Developing students' meta-cognitive knowledge and skills. In H. J. Hartman (Ed.), *Metacognition in Learning and Instruction,* pp. 33-67, Dordrecht, Netherlands : Kluwer.

http://www.dm.unipi.it/~didattica/CERME3/proceedings/Groups/TG3/TG3_Panaoura_cerme3.

Kazemi F, Fadaee MR, Bayat S (2010). A Subtle View to Metacognitive Aspect of Mathematical Problems Solving. *Journal of Procedia Social and Behavioral Sciences 8 (2010) 420–426.*

Kazemi F, Ghoraishi M (2012) A comparison between two methods of measurement of meta-cognitive awareness on mathematical problems solving of university students. *Journal of Procedia Social and Behavioral Sciences. Conference of wces 2012. In press.*

Lucangli D, C Cornoldi (1997), "Mathematics and Metacognition: what is the Nature of Relationship?", *Mathematical Cognition*, 3, 121-139.

Mau WC, Lynn R (2000). Gender differences in homework and test scores in mathematics, reading and science at tenth and twelfth grade.Psychology, *Evolution and Gender. 2, 119– 125.*

Mayer JD, Salovey P (1997). What is emotional intelligence? In P. Salovey& D.J. Sluyter (eds.): Emotional development and emotional intelligence: *educational implications (pp. 3-31). New York: Basic Books.*

McLeod D (1992). Research on affect in mathematics education: a reconceptualization. In D.Grows(Ed.), *Handbook of Research on Mathematics Teaching and Learning* (pp.575-596). New York: McMillan Publishing Company.

Nelson D, Low G (2003). Emotional intelligence: achieving academic and career excellence. Upper saddle river , *New jersey : prantic-Hall*

Panaoura A, Philippou GI, Christou C (2003). Young Pupil's Metaco-

gnitive Ability in Mathematics. European Research in Mathematics Education III: Group3.
Salovy Mayer JD, Caruso DR (2001). The positive psychology of emotional intelligence, *The handbook of positive psychology, New York, and London oxford university press.*
Schoenfeld Alan H (1985). Mathematical problem solving, *Academic Press, INC, Harcourt Brace Javanovich, Publishers.*
Tan LM, Lasward F (2008). Impact of prior content and matacognitive knowledge on students performance in an introductory accounting course. *Pacific Accounting Review , 20 ,63.*
Yong L (2003). The yong EQ inventory norms and technical manual. *http://lpi.leonard.com.my/pdf/Yong%20EQ%20Inventory%20Norms%20Technical%20Manual.pdf*