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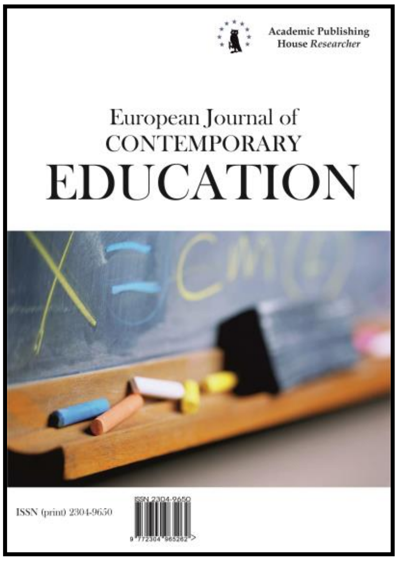

The Effects of Training and Other Factors on Problem Solving in Students

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Abstract

The purpose of this article is to identify the factors which affect students' creative thinking in problem solving. The research which was performed was quasi-experimental. It used one experimental group and two control groups from three second-grade high school classes. They received either traditional, active or heuristic problem-solving training. In the traditional method, no teaching aids were used, and the material was taught traditionally. In the active method, 34 students were trained using teaching aids, such as coloured balls, and handicrafts, such as shirts and pants. They were trained to use the teaching aids in order to solve problems. In the heuristic method, the researcher introduced problems which the students thought about. After a few sessions, I commenced teaching the procedures — in each session, two heuristics were introduced. They learned to use these strategies to solve problems. Creativity and mathematics tests were given to the students, both before and after they received training in problem-solving. The findings show that parents' education (but not gender) and parents' job type affected students' ability to think creatively. Students' creative thinking was improved by active training, but not by the heuristic or traditional methods.

Keywords: creative thinking, problem solving, traditional method, active method, heuristic method.

1. Introduction

A six-year-old boy, born with an enlarged head, seemed to have a brain disease. Three of his sisters and brothers had died during the process of being born. His mother did not agree with her relatives' and neighbours' opinions about the baby's assumed abnormality. The child was sent to school and recognised as being psychotic. His mother was very disappointed with this matter and

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prevented him from attending school, believing she could educate him at home. This child grew up and went on to invent the light bulb, gramophone and microphone. His name was Thomas Edison.

Although the above example does not reflect all intelligent children, it explains many things about such children. Can intelligent people succeed without special attention? What happens when they are introduced as unsuccessful individuals? How many of their talents and skills will be lost due to lack of attention? How badly will their abilities be damaged if they fail at school? How badly will society be damaged from their lack of success?

One of the most important goals of teaching mathematics is to improve people's intellectual abilities. One of the roads leading to this goal is via solving problems in the classroom. Problem solving is one of the basics in maths teaching. It is one of the five (National Council of Teachers of Mathematics) process standards (performance statement of 8thdecade), one of the eight octal standards, the main axis of the maths syllabus in Singapore, and is an emphasised issue in the Chinese syllabus (Bruun, 2013).

What distinguishes creative thinking from ordinary thinking relates to the originality and novelty of ideas. In this way of thinking, creative methods attract the attention of an individual. Besides originality, the ability to produce new ideas (Gil et al., 2007) is one of the most important components in problem solving. According to Kontoyianni, Kattou, Pitta-Pantazi and Christou (2013), originality, fluency and flexibility are the main factors of mathematical creativity and problem solving. In this regard, Panaoura (2014) maintain that creativity is one of the most important factors in problem solving. Githua (2013) holds that there is no one, unique, accepted definition of creativity. Panaoura (2014) argues that some researchers describe creativity using words that relate to conceptual thinking, which involves problem solving.

Problem solving is a human activity, which is done by thinking and by practice. *Polya* (1962) views problem solving as the conscious search for a suitable instrument with which to achieve a certain goal, which initially appears to be inaccessible.

Problem solving is one of the most important elements in the teaching of mathematics. Before teaching problem solving, efforts to teach other math skills and content is not particularly efficient. The difficulties experienced by students in performing calculations should not be a barrier to learning problem solving strategies (Klein, 2003).

Problem solving activities have a concrete, external, and distinctive purpose. Creative thinking, on the other hand, is a new, independent, and popular way of thinking, and often has a personal aspect that depends on intuition and analysis (Runco, 2007).

Scientific studies are related to creative power – in other words, we all have creativity to different degrees. These experiments have shown that the degree of creativity is related to intellectual power and efficiency. Hence, it is more connected with effort and perseverance in problem solving, than to internal intelligence (Vidal, 2008).

Creative thinking has a crucial role in organisations, societies and individuals. Developing it is one of the most important issues in the realms of institutional psychology and family nurturing. Accordingly, teachers and researchers should pay more attention to creativity at home and at school.

There is a vital need for reviewing our lifestyles and beliefs, by creating new methods of supporting creativity in the family, civil service, social and institutional systems. In other words, we need creative and innovative people *more* than disciplined students or clerks. So, it is necessary to identify educational methods and policies that support creative thinking. Educators and teachers should help students to cultivate their talents and abilities. What is most important is to pay attention to creativity in problem solving. When creativity is cultivated by educators, it improves students' creativity and innovation, leading to new solutions in later professional life. Due to its nature, various teaching methods should be used in teaching math, based on the context. New teaching methods emphasise the development of creativity and creative thinking in students, and schools try to nurture creative thinking. Teaching maths or pedagogy in math is a branch of human science which has achieved an important position, particularly in recent years, in science assemblies, especially in developed countries. Maths is used to study questions which also require other branches of human sciences, such as maths history, psychology, sociology and educational sciences, to be understood (Tabesh et al., 2000).

Some of the concepts which will be investigated in this study are: creative thinking in problem solving, the stages of creative thinking, the importance and necessity of creative thinking, areas of creativity, the relationship between gender and creative thinking, the relationship between parents' education and creative thinking, the relationship between traditional, active, heuristic teaching methods and the teaching of problem-solving with creative thinking, as well as factors affecting the development of creativity in problem solving. According to the above, and the necessity of paying attention to teaching methods and creative thinking in students, the researcher aims to study students' creative thinking by traditional, interactive and active methods and answer the question: Do teaching methods affect creative thinking and students' maths scores?

In one study using Tornes creativity tests on 225 school students, it was demonstrated that active teaching methods are effective in improving students' creativity, especially that of female students. On the other hand, students showed the lowest degree of improvement in creativity, with traditional methods. After one year, their creativity was even lower than the baseline, compared to the other group. In another study by Haddon and Lytton (1968), an "active class" and a "traditional class" were compared. It was shown that actively-taught students had superior divergent thinking after four years of primary school (Lester, 1994).

In his studies, Bruun (2013) found that American teachers do not use all problem- solving heuristics in their classes. They mostly use a combination of figure drawing and the key information pertaining to the problem.

Shoenfield (1985) refers to Polya describing heuristics. I have understood this approach and, later on, used it. I regretted not having learnt them before. In fact, using these strategies gave maths education new and useful challenges.

Savizi (2006) showed that the teaching of problem-solving heuristics can improve this skill and open new horizons to students, providing that it was done with precision and precaution, where appropriate. Wilson et al. (2004) warned that emphasising problem- solving strategies should guide our thinking because, based on Polya, the aim of problem-solving strategies is to learn how to think. Teachers' metacognition has a thoroughly recognised, positive and favourable role in classroom education. Therefore, modifying teacher training programs and teachers' in-service training would appear to be necessary. Lester (1994) states that no studies have confirmed improvements in student problem solving according to a syllabus which contains concepts and procedures, posing of problems, and the teaching of problem-solving heuristics.

As a result, few studies are conducted on this issue these days. Lester says that, if we expect students to be professional problem-solvers, we should change our attitude toward problem-solving. Problems are not something external and injected into a maths syllabus. Problem-solving heuristics and strategies need to be taught. In fact, maths courses contain a combination of problems and problem solving. Teaching is performed through problem-solving, and concepts are extracted and learned from problem-solving (Vidal, 2003).

2. Literature review

Based on existing studies and observations, when most students encounter a problem, they don't know where to start in order to solve it, or how to use the problem's information and data to find the answer. So, to improve students' problem-solving skills in maths and study their way of thinking, problem-solving subjects should be identified. Teaching problem-solving in maths and in contexts which involve questioning, does indeed help students to develop a deep understanding of mathematics. In this study, an effort was made to provide contexts in which talented students, individually and in groups solved problems, were able to use mathematical concepts in novel problems, and could show their creativity and innovation. Our purpose was to determine the factors that affect problem-solving and creative thinking (Jahanipour, 2006).

Polya (1962) believed that the most important purpose of teaching maths is to cultivate the ability to think and reflect properly. He also believed that this type of thinking, at least in the first instance, is equivalent to problem-solving. He saw problem-solving as an essential part of school maths courses, and believed that teaching problem-solving in maths courses is an amazing opportunity to shape the intellect of students and, thus, increase their ability to understand. More than being just an instrument to perform a job, maths improves creativity and thinking, reasoning ability, logic and aesthetics.

Everybody has a common intelligence, ability of understanding, learning, and enjoying math in different levels. Thus, the duty of every educational system is to provide a situation which is suitable for teaching and learning mathematics, and motivating students (Adamset al., 2007).

As Schoenfeld (1985) said, teaching maths in brief means whatever is related to teaching and learning math. New Viewpoint insights in teaching maths give great attention to the importance of thinking and reasoning, meaningful understanding and knowledge of concepts, and problem solving. They emphasise that students are individuals with different abilities to learn maths and, briefly, the task of researchers in mathematical education is to ensure that learners can enjoy the amazing world of mathematics.

Nekouei (2001), in studying the relationships between the school environment and the creativity of female high school students in Tehran, concluded that there is a direct and meaningful relationship between the ideal school environment and the development of creativity in students related to the organisational environment of schools.

2.1. Traditional method

In traditional teaching methods, the teacher plays an active role in teaching and presents predefined materials orally. The students do not interact very much. The only responsibility of the traditional method is to fill students' memories with information and knowledge. As a result, creativity does not have an active role in this method. The abilities to read and write are considered the most important skills to be acquired in traditional teaching. Information is learned from teachers presenting information orally, with the students repeating and memorising it. Therefore, students' minds are filled with irrelevant information. They are deprived from learning comprehensible lessons and there is no effort being made to answer challenging questions. The traditional method is called the "Socratic method", the new methods of which are speech, verbal, exploratory, and question and answer. The teacher is the only speaker in this method. He explains everything and poses the problems. In this method, students apparently make progress, but there are negative effects on their creativity in the long term. Traditional methods do not relate to the real world of students and are, therefore, inappropriate. By not challenging students, they constitute a boring educational milieu. This can lead to a lack of curiosity, questioning and cooperation from the student. In order to fill this gap, active and dynamic teaching should be used to avoid such superficial attitudes (Miri, 2011).

In this way, the teacher explains the lesson accurately, and students only write notes; in other teacher sessions, they ask questions pertaining to the same subject.

2.2. Heuristic method

Polya (1945) was the first to propose problem-solving heuristics, but he never claimed that they can be taught. Shoenfeld collated the results of his research, which was conducted over several years, in a book called *Solving Math Problems* (Shoenfeld, 1985). It outlined methods of problem-solving used by experts and novices, and the elements of problem-solving. He believed that teaching a limited number of problem-solving heuristics, under controlled and certain circumstances, could improve problem-solving skills in novices; however, due to the complexity of utilising heuristics in practice, they cannot be generalised (Shoenfeld, 1985).

Therefore, problem-solving is an important skill to be taught in mathematics classes. Trying to teach all the skills and mathematical content, prior to teaching problem-solving, is almost useless, and students' difficulties in arithmetic should not be considered an obstacle in learning problem-solving strategies (Klein, 2003).

In recent years, some research has focused attention on heuristics in improving problem solving. Polya defined heuristics as the strategies that professional mathematicians and problem solvers use to solve maths problems (Polya, 1985).

Shoenfeld believed that heuristics were strategies and techniques for creating methods to solve unfamiliar problems and define rules to solve the problem efficiently. As quoted by Polya, "they are discovery tools" (Miri, 2011).

Heuristics are the strategies which mathematicians and skilled problem-solvers use to solve mathematical problems. Some important heuristics include: drawing shape heuristics, setting a systematic table, removing undesirable alternatives, modelling, "guess and check", sub-problems (problems which are simpler and more relevant to the main material) and algebraic strategy. Broner (1960) defined heuristics as methods and strategies to facilitate problem-solving.

2.3. Active method

In active learning, each student learns at his or her own pace, and has the opportunity to think about the problems. Students figure out concepts gradually, via a problem-solving process. Instead of watching the teacher solve problems, they practice it step-by-step by themselves.

Their confidence is increased by discovering their own capabilities, because they have obtained the results and discovered the rules. They are interested in the information and feel that they own it, leading to the desire for further knowledge. Students grow in the process of active learning, and their logical thinking is enhanced (Tabesh, 2006).

In teaching problem-solving, the student is free to choose his favourite approach, to evoke every kind of knowledge he likes, and to evaluate his opinions in a way he is comfortable with. In the challenge of solving a problem, the student succeeds in explaining and evaluating his and his classmates' thoughts. He can organise his thoughts and own his knowledge. Teaching is not the responsibility of the teacher alone, but it is a bilateral activity of both teacher and students, and includes interaction between the teacher and students, and between the students themselves (Tan, Laswad, 2008).

In the active method, the student solves problems with the help of the teacher. Hence, it is centered on the student. The student is actively involved in the process of learning, he faces the problem, thinks about the solution, and solves it with the help of the teacher. He figures out the concept him/herself, by engaging in educational activities. This is how students are attracted to problem-solving. The success of this method depends on teachers' virtuosity and command over the lesson (Stigler, Hiebert, 1999).

In the active method, students are involved in the learning process. They are the centre of the classroom and, unlike teacher-centred and passive methods, they are actively involved in learning, face the problem, think about the solution, and solve it with the help of the teacher.

In the active method, students should be active and dynamic, and participate actively in learning. A student encounters a problem, thinks about its solution and, during the process, understands the concept himself, and gets help from the teacher if necessary. In this method, the student's logical mind-set is developed, and he shows a willingness to solve the problems. In this method, the teacher pays attention to the individual students and, by guiding them, improves their interest and self-confidence.

3. Methodology

This research made use of a quasi-experimental design. It used one experiment group and two control groups from three second grade high school classes to study traditional, active and heuristic teaching methods. Traditional methods were taught without using any teaching aids, and the students were tested with various problems. In the active method, 34 students from second grade science classes were selected, and the combination points were taught in several sessions, utilising the active method during the process, teaching aids such as coloured balls and clothing were used. Students could solve the problems by matching problems with balls and other patterns, both concretely and tangibly. In the heuristics method, the researcher selected 24 students from second grade science, to study the influence of heuristic teaching on their creative thinking and problem-solving. In the first sessions, I introduced some problems and the students thought about them and wrote down their thoughts. After some sessions, I started to teach the heuristic procedures. In each session, two heuristics were introduced. They learned by solving some problems and using some heuristic strategies. Then, a creativity test and mathematics exam were respectively conducted in two phases — before the heuristic teaching (pre-test) and afterwards (post-test).

Several instruments were used to collect data, including standard questionnaires, interviews with students, a maths test, as well as students' notes and group evaluations. Data analysis and statistical tests were performed with SPSS software.

The topic I considered for teaching in the traditional and active way was combinational mathematics. Not only is it an interesting topic in maths, but it also provides an appropriate subject for challenging students in the process of problem solving. It is also a useful tool for communication, modelling and improving creative thinking.

In the traditional model, I taught linear, circular and gyrate permutation, as well as combination formula $c(n,r)$ and order formula $p(n,r)$. In this model, I did not use any supplementary tools, and taught the lesson in the form of a presentation. Students simply took notes without performing any other activities. I felt that students were just memorising in the form of rote learning, and could not understand the issue at hand on a deeper level. Their questions revealed that there were some unclear ambiguities in their minds.

In the active model, I took an equal number of red, blue and green counters to the class. We examined the number of linear, circular and gyrate permutations using red, blue, and green colours. For circular permutations, students made a bracelet using a thread and the counters. As a result, they understood the distinction between circular and gyrate permutation very well.

In order to teach the concept of combination c(n,r), we firstly numbered the counters. We put two red counters, R_1 and R_2, one blue counter, B, and three green counters, G_1, G_2, and G_3, in a container. I asked the students to take two counters, randomly, from the container. Then, they wrote down the various possible combinations of counters that they could have (R_1G_3, R_1R_2, G_1G_2, etc.).

It was a fascinating exercise for the students. They said: "now we can easily understand why there are so many possibilities. We had never paid attention to this. We have three green counters, G_1, G_2, G_3, so they are different". In fact, they hadn't reached that in-depth understanding. They wrote all the possibilities down, and they got 15. When they understood the concept very well, in an observed way, they referred back to the formula and they got 15 again. They were absolutely thrilled.

In teaching with heuristics, I explained one of the solutions to the problem in each session, and I did so using a sample question. Drawing a picture, forming a systematic table, eliminating in appropriate possibilities, pattern finding, trial and error, sub-questions, using simpler and more relevant questions to the main question, and the algebraic method, were among the utilised strategies.

I tried to use each strategy in every session to resolve questions and expand students' knowledge of the methods and strategies of problem-solving. The purpose of my doing so was to allow them to understand that there is not just one possible way to obtain the answer. Instead, they should think about the question in different ways.

Examples of questions answered using the heuristic model:

1. The strategy of drawing a picture: The question of the chickens and cows.
2. The strategy of eliminating inappropriate possibilities: The question of the orange seller.

3.1. The question of the chickens and cows

Suppose a farmer has a total of 22 cows and chickens. They have a total of 56 feet. Imagine that none of them has any deformation. How many chickens and cows does the farmer have?

We reminded the students that they did not necessarily need to form an equation to solve the question. A primary student can understand this question simply by drawing a picture as follows: Draw and circle for each animal. We first draw two feet for each one of them to obtain a total of 44 feet. The question stated that there were a total of 56 feet. Therefore, we need to turn some of the "chickens" into "cows" by adding another pair of feet. We then end up with 16 chickens and 6 cows.

3.2. The question of the orange salesman

The orange salesman, who seems to be a very naïve man, invites his new neighbour, who happens to be a math teacher, to a dinner party. The orange salesman and his wife welcome the neighbour and his family. The neighbour asked the orange salesman, "Where are your children?" The orange salesman said: "They are playing." The neighbour asked, "How many children do you have and how old are they?" The orange salesman answered cleverly: "I have three sons. The product of their ages makes 72, and the sum of their ages equals our house number. The neighbour, who was confronted by this surprising question, went to the door of the house and looked at the house number. He then came back and said: "The question is vague." The orange salesman said: "Oh, I'm sorry. You're right. My oldest son is very keen on cycling.

At first, all the students laughed at the question. I gave them some time to think about the question carefully, and not lose hope on resolving it. One of the groups said, "What is the meaning of: 'The question is vague?'" I said, "It means that there is more than one possible answer to the question." The students were discussing and exchanging opinions, and I was supervising and guiding them. Eventually, one of the groups shouted: "We have resolved the question!"

We noted down the different combinations of ages that could be multiplied to obtain 72 (Table 1).

Table 1. Which was used to solve the problem of the orange salesman

First son's age	Second son's age	Third son's age	SUM
1	2	36	39
1	3	24	28
1	4	18	23
1	6	12	19
1	8	9	18
2	2	18	22
2	3	12	17
2	4	9	15
2	6	6	14
3	3	8	14
3	4	6	13

Due to the fact that the neighbour pointed out the vague nature of the question, after seeing the house number, then the two lines which calculated the sum as 14, must have contained the answer (rows 9 & 10). When the orange salesman said, "my eldest son is fond of cycling", then row 9 could not be the correct answer, because there were two "eldest sons" (both six years old). Therefore, his eldest son must have been eight years old, with the other two being three. We can see that students obtained the correct answer in an interesting way, just by creating a table and eliminating inappropriate possibilities.

3.3. The question of chess

How many squares are there on a chess board? Count them again. There are some more…

In one of the problem-solving sessions, I asked students to think about this question and to give me their opinions. We tracked their thinking and discussion processes.

Maryam: This question is very simple. We have 64 squares, because a chess board is 8 by 8 squares.

Sara: No, that's not correct. We can see other squares.

Maryam: Yes, you're right. This question is harder than I thought.

Mina: Let's simplify to get down to the main question.

This conversation was so interesting to me. When you give students the chance to think about a question together, the level of their creativity is greatly improved. At the end, students collaborated to form a table (Table 2).

Table 2. Process of solving the chess-related question

Size of chess board	Number of squares
1*1	1
2*2	5
3*3	14

Then, they were looking for a pattern to solve the main question. Suddenly some students said they found the pattern, and they explained it really well. The answer to the main question was: 1+4+9+16+25+36+49+64=204. I said, "Well done, guys. How beautiful it was to see you resolving the question by collaborating and discussing and using heuristics."

The entire population of the second grade at high school in Kashan consists of 4268 people, of which 450 were selected for the pre-test. To perform post-tests after traditional, active, and heuristic teaching, 81 people from three classes were chosen using random cluster sampling.

4. Results

Hypothesis 1: Gender affects students' creative thinking.

To test hypothesis 1, independent samples *t*-tests were used. The results are shown in table 3.

Table 3. Two sample *t*-tests for hypothesis 1

	Levene's test		Means equity					
Creative thinking	*F*	*p*	*t*	df	*p*	Mean difference	95 % confidence intervals Upper	Lower
Variance equality	0.012	0.914	0.204	449	0.838	0.2645	2.27	-2.80
Variance inequity			-0.204	441.97	0.838	0.2645	2.80	2.81

Table 3 shows that the *p*-value (0.914) of the Levene's test was more than 0.05, so the equity variance hypothesis was accepted. The *p*-value (0.838) of the *t*-test for means equity was greater than 0.05, thus the mean difference between the creative thinking scores of female and male students was insignificant.

Hypothesis 2: Parents' education level affects students' creative thinking.
An ANOVA was used to test hypothesis 2 of this research, with the results shown in table 4.

Table 4. ANOVA test of hypothesis 2

Creative thinking	*F*	SS	df	MS	*p*
Between groups	2.09	3832.55	440	383.25	0.024
Within groups		183.39	450	183.39	

The results of table 4 show that the *p*-value (0.024) was less than 0.05. Therefore, parents' mean level of education and students' mean level of creative thinking do not correlate, and there is a significant relationship between parents' education and students' creative thinking. To test differences in the average level of parents' education and students' creative thinking, Tukey's test were used.

Table 5. Tukey's test

Education	Number	Group 1	Group 2
Illiterate	20	1.32	
Under diploma	207	2.43	
Diploma and junior college diploma	105	2.39	
BA	75		2.58
MA	23		3.02
p-value	0.325 level of significance (0.000)		

According to the Tukey's test, the creative thinking of illiterate, under diploma, diploma, and junior college diploma groups had no significant differences, but means of the BA and MA groups were higher than those of the other groups.

Hypothesis 3: Parents' job affects students' creative thinking.
To test hypothesis 3, an ANOVA test was used, with the results shown in table 6.

Table 6. ANOVA test for hypothesis 3

Creative thinking	*F*	SS	df	MS	*p*
Between groups	1.30	2672.92	439	242.99	0.219
Within groups		8185.21	450	186.45	

The results of table 6 show that the *p*-value (0.219) was more than 0.05, so the mean of parents' job and students' creative thinking are the same and there weren't any meaningful differences between parents' job and the students' creative thinking.

Hypothesis 4: Students' performance varies after receiving active, heuristic or traditional training in problem solving.
To test the Hypothesis 4 of the research, ANOVA was used (table 7).

Table 7. ANOVA test for Hypothesis 4

Creative thinking	F	SS	df	MS	*p*
Between groups	4.76	1543.76	439	324.043	0.000
Within groups		6732.91	450	13.982	

The results of table 7 show that the *p*-value (0.000) was less than 0.05; therefore, the mean problem-solving ability of students receiving various types of training were different. To show the differences between means, a Tukey's test was used (table 8).

Table 8. Tukey's test

Training method	Number	Group 1	Group 2
Traditional	23	11.9	
Active	34		13.8
Heuristic	24	9.5	
p-value		0.699	0.001

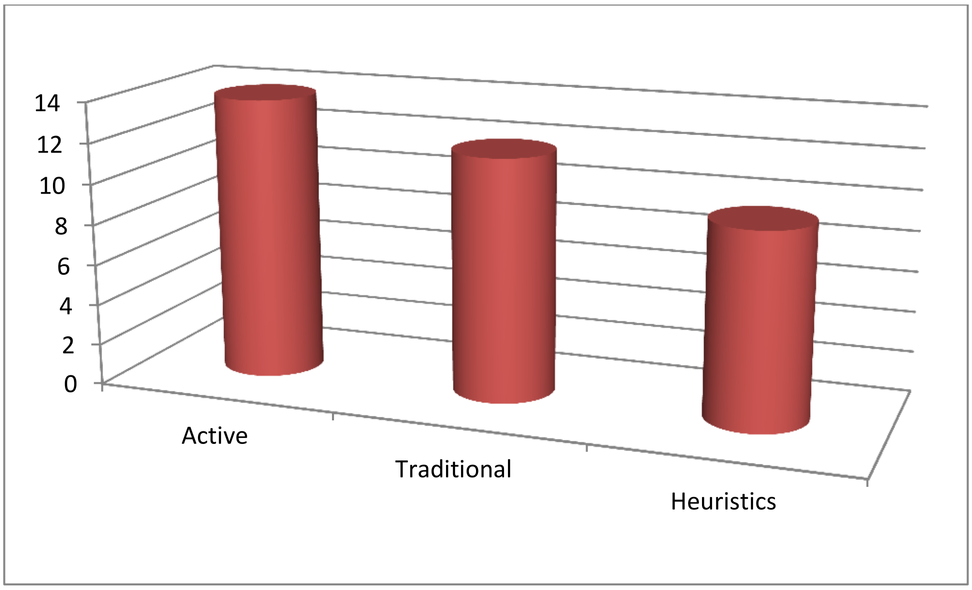

Fig. 1. Mean problem solving ability after receiving one of three teaching methods.

There was a significant difference in students' problem-solving abilities, according to the training method they received. To show the differences between means, a Tukey's test has been used, with the results shown in table 8.

Based on results of table 8 and the *p*-value, there was a clear difference between the active, traditional and heuristic teaching methods. The active method resulted in better performance than the other two methods, which had similar performances.

5. Discussion

Even advanced educational systems believe that they haven't been able to train creative individuals. We can run to catch up with the rest of the world by cultivating children's talent in Iran! As we have this power, why do we doubt it?

Mathematics teaching or, should we say, "education in mathematics", is a branch of human science which has a very important place in the scientific in situations of the world, particularly in developed countries. Mathematics training involves studying questions which require other sources of human knowledge to answer, such as mathematics history, psychology, sociology, and so forth.

In this way, in mathematical education, different subjects in terms of content, learning process, teaching methods and individual differences in learning are controversial.

Each individual with a typical level of intelligence is capable of understanding, learning and enjoying mathematics at different levels and grades. Thus, each educational system is responsible for providing proper teaching and learning conditions for mathematics, and for creating motivation within the learners.

Problem-solving skills are one of the most important subjects in learning. Generally, teaching mathematics through problem-solving can create conditions in which students focus on practicing mathematics actively and creatively. One of the most important questions about this has been resolving the problem of, "exactly what do people do when solving a problem?"

Regarding the mathematical behaviour of students solving a problem, especially intelligent students, recognising their abilities is an important issue.

Sanders emphasises that, in order to teach creativity to children and adolescents, we should allow them to think and speculate, and avoid pre-determined activities.

On the other hand, the individual creativity of the teacher plays an important role in creativity. A creative teacher can recognise and encourage creativity within his or her students. By providing creative conditions, they can provide opportunities for students to rely on their logic in solving problems creatively.

Headmasters, teachers and parents must provide the conditions to reveal the potential and hidden abilities of these learners. The current belief is that when a nation is not able to utilise its remarkable talents, it has wasted its human capital. In view of economics and politics, failure to educate remarkable talents is, indeed, negligence of future society.

Nowadays, due to the extraordinary importance of maths, and its effect on people's daily lives, we should pay close attention to maths-teaching methodologies in the syllabi of educational courses, and remove the barriers to improving problem-solving skills in students.

This study found that gender and the parents' occupation type did not affect students' creative thinking. However, parents' education level did have an effect, such that there were differences in the mean scores of children of illiterate, under diploma and junior college diploma-qualified parents, and those with BAs and MAs.

In the analysis of the results, it can be said that creativity is found in every single person, to some extent. As Torrens (1974) showed in his investigation of the role of gender in creativity, there is no significant relationship between creativity and gender. In the analysis of this result, and with due consideration of the fact that most parents were self-employed, it can be concluded that parents elaborate on the creativity and significance of their own job less, because they prefer their children to be educated. As a result, few children pursue their parents' profession.

The analysis of the results shows that highly-educated parents pay more attention to their children's creativity, and create situations in which they can express it. Therefore, parent groups could be formed at school in which to exchange ideas and cooperate with teachers, with a view to the utilisation of the available facilities, in order to improve their children's creativity-levels.

The intelligence quotient (IQ) of students is not enough to predict their educational progress. Other issues, such as favourable social, educational and family conditions, can prevent the wasting of their talents and abilities, so that they can easily reveal their special and remarkable talents.

There were significant differences between the problem solving abilities of students according to the teaching method they received (traditional, active, and heuristic).

Based on the results of this study, it is concluded that the traditional method (with the teacher teaching in detail and solving the problems) does not develop students' creative thinking. It also does not cover all maths problems, and causes confusion in students.

Students' views of mathematics affect their thoughts, mathematical function and grasp of mathematical concepts. Additionally, it will affect their future decisions about studying mathematics. Thus, teachers must not allow students to learn mathematics in such a way that they imitate the teacher, as they will lose interest in maths.

The heuristic method did not affect students' creative thinking. Therefore, it is suggested that teachers use active and collaborative methods, in order to solve maths problems.

Different approaches to solving maths problems have been mentioned, including heuristic, traditional and active. These three methods correspond with the three historical stages of education (teaching-centred, information processing and student-centred).

Direct teaching methodologies are a unidirectional flow, and the teacher's task is to transfer some predefined information to the students. On the other hand, the students' task is to be passive and to not participate in decisions regarding plans and educational activities. In such an educational milieu, students would never get a chance to practice team skills, leading to a lack of interest in cooperating and collaborating with others and, ultimately, individualism (MehrMohammadi, 2007).

The student must be trained in problem-solving methods, so that he or she can use different strategies when confronted with different issues. One of the methods to help students to be receptive towards maths, is to provide a mathematical environment different from the one they had experienced in school, and give them opportunities to speculate and deepen their problem-solving skills.

The power to inspect and assess solutions, and recognise ways of thinking by metacognition skills, is good. Students who learn metacognition skills are more efficient in thinking about, rationalising and solving problems, leading to more creative and thoughtful work. Instruction in the use and selection of explorative problem-solving strategies is very important. By using this idea and providing problem-solving classes, strategy selection can be taught. Therefore, teachers must learn these methods and use them in class to teach students how to think mathematically, and not learn other mathematical ideas.

A Chinese proverb says, "If a fish is given to a man, he will only have a meal to eat. But if fishing is taught to him, he will always have a meal to eat." So, essential changes must be made in teaching maths.

In fact, there is a mutual interaction between the students and the teacher, and between the students themselves. We suggest reducing the extent of the syllabus in the traditional method, and take into account the quality of education. It is proven that knowledge, acquired by exploration and free research, can be better retained in the mind, allowing students to learn methods which they can mae use of use of for the rest of their lives. They also increase their curiosity gamut consistently, and learn to use their brains. As a result, they would be able to formulate their own concepts and imaginations independently. Therefore, implementing active methods not only arouses students' enthusiasm, and strengthens their learning motivation, it also allows the teacher to create a small and desirable community within the class. So, creating and improving such an atmosphere will trigger students' sense of curiosity.

Providing and facilitating ways to improve creative thinking in schools has wide implications, ranging from changing attitudes to teaching methods. The attitude of the teacher towards the lesson, his or her interest in teaching, use of supplementary materials, preparing an appropriate environment in the classroom so that students can think, students' conversation and questions, holding problem-solving workshops in groups, and using active and modern ways of teaching, altogether leads to the improvement of children's creativity-levels. It is suggested that those teachers who utilise heuristic methods pay close attention to the fact that teaching heuristics alone does not lead to any improvement in problem solving. In fact, content and conceptual knowledge is the prime issue in this process.

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