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The effect of teaching problem solving skills and locus of control on the academic achievement of mathematics students

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ABSTRACT

This study was conducted with the aim of analyzing the effect of teaching problem solving skills and Locus of Control on the academic achievement of mathematics students. The research method was quasi-experimental with a pre-test and post-test control group design. The study's population comprised of students studying in the third year of Guidance school during the academic year of 89-90 in the town of Lordegan from which 30 students were selected via multi-stage cluster sampling. The subjects were then randomly divided into the experimental group who were taught problem solving skills and locus of control and the control group. To measure the reliabilities of the academic achievement tests and the open- trial test the researchers used Cranach Alpha which showed reliability coefficient .88 and .84, respectively. The data were analyzed through covariance analysis. The results showed that the teaching of problem solving skills and Locus of Control had significantly affected the academic performance of the mathematics students ($p<0/001$). The results of Turkey's post-hoc test revealed that there was no significant difference between the effects of teaching problem solving skills and the teaching of Locus of Control on the academic performance of the experimental group's students ($p>0/001$).

Introduction

Throughout the history of teaching and training, problem solving has been one of the important goals of teacher training. When a learner is faced with a situation wherein he is unable to use his information and skills that he/she possess at the moment to produce the correct answer to a question, he/she is said to have encountered a problem. Problem solving in the form of analysis and the use of skills can result in either the learner's correct response or the accomplishment of the intended goal (Seif, 2012). One of the most important goals of teaching and training in every society is the training of students to easily overcome the difficulties and problems that may arise both in their day to day social lives as well as in their educational environment (Selcuk, Caliskan,and Erol, 2007). The teaching of problem solving is a method by which the student can learn how to use his/her set of cognitive skills to solve difficult problems effectively. An approach to problem solving can serve as a tool for identifying and solving many of the problems a student faces. Problem solving has often been associated with such terms as independence, competence and self-confidence. It is a process by which a person tries to find a suitable solution to a problem (Perla and Donne, 2004). The process of teaching problem solving consists of 5 stages which includes the following: (i) Identifying the problem (ii) Defining and expressing the problem (iii) Exploring possible solutions (iv) Working on the possible solutions to overcome the problems and (v) Looking back and evaluating the results of the activities performed (Saif, 2012). It is believed that by training students on problem-solving, there would be an increase in their levels of self-efficacy and efficiency leading to an increase in their academic achievement (Woolfolk, 2001). Thus, an efficient educational system consists of problem-solving training that helps the students discover the necessary knowledge, skills and attitudes in order to overcome their academic difficulties (Altun, 2003). In problem solving it is not acceptable to find only one specific solution to a specific problem. It is important that the solution of an abstract principle or law obtained can be generalized to other situations (Mohammadi, 2006). From the perspective of most researchers, problem solving is the best example of contemplation and reflection of life. It should be mentioned here that the cause of new problems in life is mostly due to the lack of problem solving skills and the use of ineffective strategies that not only augmented the problems but also created new difficulties and problems. Results of much research work on this area have shown a consistent relationship between the teaching of problem-solving skills and the increase in the students' ability to solve problems (Atkinson et al., 1983). The teaching of problem solving skills can facilitate students especially in the mathematics courses to develop their learning skills resulting in an improvement in their academic performance (Malouf, Thorsteinsso & Schuttle, 2007). In view of the fact that mathematics is one of the courses wherein students face new problems every day, the teaching of problem solving skills was considered essential. In addition to problem-solving skills, locus of control was also considered as an important factor affecting the academic achievement of mathematics students. Locus of Control can make a person to belief in the power of his own influence on his life. The concept encompasses two dimensions; both internal and external. Julian Rotter (1966), one of the theorists of Locus of Control, has built upon her theory about a person's belief system is contingent on the reinforcement of his/her resources. According to this theory,

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it is believed that the influence of the Locus of Control can be divided into two groups; the first group consists of those who base their successes and failures in life on internal factors while the second are of the opinion that external factors control their successes and failures in life. Thus, the former group is believed to possess internal resources of locus of control and the latter is believed to have external resources locus of control (Seif, 2012). Those with external resources of locus of control hold positive or negative perceptions of events and incidents as being not related to the individual's behavior and thus beyond the individual's control. They believe in luck or have an external locus of control. Those with internal resources of locus of control are those who believe in autonomy and self-control of their own destiny and thus believe that an individual can control his/her life from within him/herself. The ability to control the outcome of a positive or negative perception of the events and incidences is what relies on a person. Weiner (2005), in his theory of three-dimensional model of attribution, presents a relationship between the dimensions of expected levels of student academic performance and the dimensions of stability. This means that if a factor shows constant results for a long period of time (for example when a student gains good scores in mathematics by employing a special style of study) gradually the student will expect stable consequences to his future activities. Several studies have shown that when students attribute failure to lack of ability, they possess an external locus of control and this will lead to less success in such a way that they become more dependent on their classes (Ozolins , Stenström, 2003). Positive behavioural reactions are due to the intrinsic factors because ability and effort provides a person with a sense of pride and self-confidence while conditions that arise due to causes such as luck, chance or as a consequence of the help of others do not have this effect. According to Weiner (1977), success and failure can show the relationship among the determiners of affective variables. When success and failure can be attributed to internal factors, pride and shame increases, but when success and failure is attributed to external factors pride and shame decreases (Saif, 2008). Studies have shown that by displacing the Locus of Control of a person from the external factors to internal factors, we can increase self-notion, confidence in performance, effort, and success. Studies of Haine and his colleagues (2003) showed that students who possess internal locus of control put more effort when attempting their math homework and as a result achieve greater academic success. Ozolins and his colleagues (2003), in one of their study found that learners who have internal locus of control have a higher level of self-confidence and are more successful in attempting their homework as compared to those learners who have a Locus of Control based on luck and other external factors. Bell Gredler (1986) says that teaching conditions should focus on learning which would encourage students to increase their efforts and in turn increases their activities and necessitates feedback and in this way their internal Locus of Control takes shape. Ames (1987), in his study showed that in a competitive educational environment, even a student with high self confidence may face failure resulting in an increase in self-criticism on his/her abilities and the lowering of perceptions of his/her ability to do math homework. These students are said to have obtained external locus of control due to their academic performance in the classroom (Kermode, 2006). Tak (2006), Kermode S, (2001) and Burk & Schwartzberg (1996) found that students with internal locus of control accept the responsibility of being school students and the duties pertaining to their roles which in turn affects their quality of learning and academic achievement (Ghasemzadeh, 1389). However, in contrast to the above study, Mostalmi (1384) showed that the training of the skills of locus of control could bring about a significant relationship between locus of control and student achievement**.**

The findings of Strickland and Bonnie(2003) suggest that students with external locus of control not only differ in their beliefs in the Locus of Control sites with those who have internal locus of control but also display several behavioural differences with the latter. For instance, they vary in their **s**trategies for information seeking in the learning environment. A big problem that mathematics teachers are facing these days is trying to deal with students possessing external locus of control as well as their inability to solve the problems, the combination of which have been causing a negative impact on the academic performance of students in mathematics. As a result this research intends to analyze the effect of teaching problem solving skills and Locus of Control on the academic achievement of mathematics students. Thus, the following hypotheses have been developed:

(i) The teaching of problem solving skills can cause an increase in the academic achievement of mathematics students

(ii) The teaching of Internal Locus of Control can cause an increase in the academic achievement of mathematics students

(iii) The teaching of Internal Locus of Control is more important than the teaching of problem solving skills to increase the academic achievement of mathematics students

Research method

The research method was quasi-experimental with a pre-test and post-test control group design. In this respect, the teaching of problem solving skills and locus of control was considered the experimental variables while the increase in the academic achievement was analyzed as the dependent variable.

Research population, sample and sampling method

The study's population comprised of students studying in the third year of Guidance school during the academic year of 89-90 in the town of Lordejan (N=**3480)**. With respect to the statistical capacity of this study, the sample size was taken as 30 students. In order to randomly select this sample, a multi-stage cluster sampling method was conducted. Thus, among the 10 Guidance school in that district, two classes were randomly selected for this purpose. Then subjects were then randomly divided into two experimental groups who were taught problem solving skills and locus of control and another group of 10 members were randomly selected to form the control group.

Research instruments

Research instruments which were used to gather data included achievement tests in mathematics designed by the Department of research and training. A program to teach problem solving skills was planned with the aid of researches who adopted two methods to solving problems methods proposed by D'Zurilla & Gottfried (1971) (quoted from Hajipoor, 2002) as well as conducting a two-day workshop in line with Williams (2004) (quoted from Lotfinia, 2007). Furthermore, a program to teach locus of Control was also planned consistent with the social learning theory of Rotter which is based on the understanding of a person that a given behavior will lead to a particular outcome, or reinforcer. Furthermore, a training program corresponding to the teaching method of Charms, R. (1968) (adapted from Lefrancois, 1997) was also implemented.

A Mathematics achievement test consisting of 30 multiple-choice was conducted. The test content validity and reliability were tested and confirmed by five experts in the fields of mathematics and Cronbach's alpha test revealed reliability

coefficient .84 and .88, respectively. The length of the pre-test and post-test was 45 minutes each and they were conducted in two stages within an interval of 60 days.

In this way, before the start of the training sessions, 30 students in a group were administered a test followed by the training of the experimental group while the control group were exempted from this training program. After the experimental groups' training, the post achievement test was administered to both the control and the experimental groups. Problem-solving training program for the experimental group were conducted in the form of seven-one hour sessions. Members of the group were introduced in the first session and the aim of the training exercises as well as the method to solve the problems described. In the second session, subsequent to brain storming, a detailed description of problem analysis and the reasons behind it caused a clear explanation of the problem at hand was given. This was followed by a group discussion about the benefits of planning when attempting to solve a problem. The importance of a student's lack of understanding of a problem and the reasons behind reaching ineffective solutions to the problems were also discussed. In the third session, transforming the difficulties and problems into simple components while eliminating ambiguities along with a simple operation explanation of the problem was considered fluency technique or brainstorming was taught and practiced.

In the fourth session, the method of brainstorming was used to test the possible and impossible solutions to the important questions were discussed. In the fifth session of the training, the students' solutions to the problems were evaluated and the subsequent important priorities were discussed and participants were encouraged to evaluate the proposed solutions to the problems as well as the correct or incorrect techniques used to derive those solutions and the advantages and disadvantages of each solution. The sixth session of the training was to prepare the way of problem solving based on the results of the discussions undertaken. At the end of this session, participants were encouraged to solve their problems based on the outcome of the training sessions by trying a step by step problem-solving procedure using the best method with the highest benefits and least flaws. In the seventh session, the students gave a report on their problem solving process and therefore the solution of problems and the usefulness of this technique in solving their problem, was assessed. At the end of each session, the task related to that particular session were given to the participants and during the interval of each session, they would attempt them and at the end of the next session a detail analysis were carried out on them.

The training of Locus of Control was implemented prior to the teaching of problem-solving skills during a seven, one -hour session. In the first session, the members of the group were introduced to the principles of education and training and the method of performing the related exercises were taught. In the following six sessions, the students were lead to base their perception of failure and success on their intrinsic factors of personal ability and effort in order to shift the Locus of Control from external to internal and therefore change these irresponsible person to those who take for their own actions and accept the consequences of their actions. In each session, the students are given tasks to enable a change and stabilize their Locus of Control from external to internal and in the following sessions these were analyzed.

Results

The means of the pre-test and post-test groups of mathematics students in the third-grade of the academic school year 2010-2011 is presented in Table 1.

Table 1

Grop	Pretest		post test	
Locus of Control	mean	Standard deviation	mean	Standard deviation
problem solving skills	11.02	1.46	15.53	1.49
control	10.45	1.48	16.31	1.71
	10.02	1.69	10.94	1.65

According to Table 1, the mean test scores of the experimental group and control group pre-tests showed no significant difference between the two groups, but the test scores of the experimental group subsequent to the intervention program showed an increase with a significant difference in the means of both groups.

Table 2

Sources of change	SS	df	MS	F	p	Eta	Power of a test.
pre-test	26.90	1	26.90	10.75	0.24	.038**0**	0.29
Group	304.65	2	101.55	40.45	0.001	0.82	100
Error	67.91	27	2.51	-	-	-	-

The result of a covariance analysis is presented in Table 2. As can be seen in the table, by taking the pre-test scores as a co-variable**,** the method of teaching problem solving skills and Locus of Control was instrumental in creating the significant differences between control and experimental groups shown in the post-test scores and results ($p<0.01$) suggests that 82% of the variance in the mathematics achievement test clearly showed that the improvements in the scores of the experimental groups was due the method of teaching problem solving skills and Locus of Control. Also, the statistical power of 100% showed the adequacy of the sample size.

Table 3

Group I	Group J	X_1- X_2	P
Locus of Control	teaching of problem-solving skills	-0.97	0.23
	control	5.59	0.001
teaching of problem-solving skills	Locus of Control	0.97	0.23
	control	7.38	0.001
control	Locus of Control	-5.59	0.001
	teaching of problem-solving skills	-7.38	**0.001**

Table 3 shows the results of the Tukey's test for the comparison between and within two groups. As it can be seen in Table 3, the experimental group (applying the method of problem-solving skills training and locus of control) showed an improvement in the academic performance of the students of mathematics ($p<0.01$) while there was no significant improvement in the control group's scores and result. Furthermore, when comparing the results of the two methods of the intervention program within the experimental groups, as compared to the teaching of problem-solving skills to improve academic performance in mathematics education, locus of control showed a higher average, but this difference was not significant ($p>0.01$).Thus, according to the above results, the results of the first and second hypothesis were confirmed but the third hypothesis was rejected because the results showed that the difference between problem-solving skills training and locus of control to improve academic performance in mathematics is insignificant.

Conclusion

This study aimed to investigate the effects teaching problem solving skills and Locus of Control to improve academic performance in mathematics students studying in the third year of Guidance school indicated that both these methods were effective in improving the academic performance of the students under study**.** The results showed that by taking the pre-test scores as the dependent variable, the method of teaching problem solving skills and Locus of Control was instrumental in creating the significant differences between control and experimental groups ($p<0.01$).Eta squared shows the amount of influence and suggests that the effect is equal to 82.0 which means that 82% of the variance in the mathematics achievement test clearly showed that the improvements in the scores of the experimental groups was due the method of teaching problem solving skills and Locus of Control. Also, the statistical power of 100%, showed the adequacy of the sample size. In general, this study showed that training of problem solving skills can improve the academic achievement of mathematics students in schools. This study corresponds with the results of research work by Selcuk, G. S., Caliskan, S., and Erol, M(2007) Malouf, G.M., Thorsteinsson, E.B., & Schuttle, N.S (2007) Atkinson, Hylgard (2004), Goldfried, Altun (2003) and Davidson (1999). These researchers believe that all students who are taught problem-solving skills can solve problems in mathematics better which will lead to improvements in their education. By teaching problem solving skills to an individual he/she will learn better and eventually achieve better academic results as well as widen their potential further learning. The definition and formulation of problems is yet another skill learnt in the problem-solving skills methodology. Nezu, A.M., Zurilla, T.J (1980) have emphasized on the effectiveness of the decision-making process which includes the initial process of defining and formulating of the problems to be attempted. This study provides empirical evidence on the effectiveness of this method in the decision making process as the results of those students in the experimental group who were trained in defining and formulating the problems prior to solving them, scored higher marks in mathematics than those in the control group who were not taught this skill. This research also provides empirical evidence on the positive effect of teaching locus of control on the academic achievement of mathematics students in schools which is in line with former reports by Tak (2006),Weiner (2005), Ozolins, Stenström U(2003), Hine and colleagues (2003), Kermode, (2001), Burk & Schwartzberg (1996), Emis (1987) and Bell-Gredler (1986). Furthermore**,** it was found that the teaching of locus of control can have a significant effect in augmenting a learner's confidence which is one of the causes of his/her improvement in academic achievement. This study also provides substantial evidence to the claims of Hein and his colleagues who found that there was a behavioral correlation between those who have internal locus of control and those who have a higher level of self-confidence. All the subjects in this research with an internal locus of control and high confidence spent a lot of time on homework and preferred to practise on various tasks and test their ability with effort instead of leaving it to luck which keeps in line with previous research of Hine (2003). The results of Mostalmi (2005) shows that there was no significant relationship between the teaching of locus of control and improvements in the academic achievement of students which does not align with this research. However, this study provides evidence which supports the works of Pintrich (2006), Phillips (1997),Gage and Berliner,(1995), and Weiner (1985) who showed that students with an internal locus of control based their academic successes and failures on their lack of effort rather than luck. Correspondingly, these students try to achieve success and in turn attain academic achievement and self-efficacy. Shank (2003) in a study showed that students who based their success on internal locus of control (effort and ability) and their defeat on lack of practise could increase their self-efficacy and motivation in the field of mathematics. In his study, the researcher has shown by training students on problem solving skills and Locus of Control there could improve their academic achievement due to a variety of problem-solving skills which is consistent with the findings of the present study.

The results of the Tukey's test showed that the students in the experimental group demonstrated a higher mean in problem-solving skills than their locus of control mean in their academic performance in mathematics but this difference was not significant. Thus, it could be concluded that both methods of problem-solving skills and locus of control can aid in the improvements in the academic performance of students in mathematics. Furthermore, this research also points to the assumption that the teaching of problem-solving skills and locus of control is essential to improve the academic performance of students in mathematics. In this regard, it is suggested that teachers and school administrators in collaboration with experts enrich the educational environment with educational games are designed to cater to the learning needs of the students and improve their skills such as problem solving skills and locus of control. This will eventually aid in the improvements in the academic performance of students in mathematics. Also, owing to the effectiveness of teaching problem solving skills, and locus of control, it is also suggested that teachers be trained to teach these skills during their in-service training so that their can make use of this method to bring about positive changes in the teaching of mathematics. Furthermore, as a means of an extension of this study, it is suggested that researchers apply the training of problem-solving skills and locus of control in their intervention methods to seek the relationship between this method and other variables such as various levels of growth such as childhood and adulthood and between boys and girls. One of the limitations of this study was that the sample under study consisted only of boys and so it is necessary to study the results of such a research on girls and students from other grades in the mathematics major in schools in order to gain more insight into this topic.

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