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Predicting university students' perceptions of problem solving skills from their mathematical success*

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Abstract

The purpose of this study was to predict the university students' perceptions of problem solving skills from their Mathematical success. To achieve this goal, points of students in Mathematical programme (*Department of Primary School Mathematics Teaching*) and points of students in Non-Mathematical programme (*Social Sciences Department and Religious Culture and Moral Knowledge Department*) were compared. This study was performed with a total of 201 students in Rize University, Faculty of Education; 110 students in *Department of Primary School Mathematics Teaching*, 35 students in *Social Sciences Department* and 56 students in *Religious Culture and Moral Knowledge Department*. In this study, *the Problem Solving Inventory* which was adapted to Turkish by Sahin, Sahin and Heppner (1993) was used. Results revealed that students' net Mathematics scores in Student Selection Examination (SSE) were not a meaningful predictor of their perceptions of problem solving skills. Similarly, it was concluded that General Mathematics Course scores of the students in Department of Primary School Mathematics Teaching Programme were not a meaningful predictor of their perceptions of problem solving skills. Points in the problem solving inventory showed no meaningful difference according to departments and programmes while they showed a meaningful difference in favour of female students. In secondary school Mathematics education, it is possible to form more settings where students can internalize problem solving processes and associate these problems with real life situations and project works with other assignments can be given to students to ensure those goals.

Key Words: Problem solving skills; Mathematical success; Student selection examination (SSE); Predicting perception.

Introduction

Humans are ever-changing and developing entities. Negative experiences, as well as positive experiences, might have positive effects on this change and development process in the end. It is possible

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to say that when an individual who faces an obstacle and overcomes it will be able to overcome following similar obstacles more easily with the help of learning from the previous one. One of the concepts which Erikson emphasizes in his psychosocial theory of development is 'development crises'. In the theory, it is accepted that each period of crises provides an opportunity for further development. Successful resolution of these crises has an effect on the healthy development of an individual's personality (Ergene, 2009; 114). So, it does not mean that negative experiences will necessarily have negative consequences all the time. A current situation may take on a different aspect with the approach of the individual. In this regard, Ellis (1998; 3) mentions that thoughts individuals develop on negative situations are more effective in their problems than the negative situations themselves. It can be stated that focusing on the solution of a situation is more useful because it is inevitable to face various problems in life. As Balci (2007) mentions, modern education should aim at raising individuals who can overcome difficulties and problems by themselves because it is impossible to predict what difficulties and needs may be faced in life. At this point, the importance of the problem solving concept becomes clear.

While it has various definitions in the literature, a problem can be described as a difficulty to overcome, a disturbing situation or a question the answer of which is sought (Aksu, 1989). On the other hand, problem solving is defined as a process consisting of a series of cognitive, affective and behavioural activities individuals exhibit towards situations they may face in life, which disturb them or make them stressful, and require a solution (Heppner & Krauskopf, 1987). In other words, it may be defined as skills which include actions developed to overcome difficulties faced in life and the ways these experiences are perceived (Ittenbach & Harrison, 1990; Zadnik & Loss, 1995). In brief, it is possible to define problem solving as a pattern of reactions exhibited in order to remove something that affects an individual in a negative way or overcome an obstacle on the way to an objective. When literature on the subject was reviewed, it was seen that problem solving skills were related with various positive and negative situations. In some studies, it was found that there were meaningful correlations between the inability in problem solving and physical and psychological problems (Unger, Kipbe, Simon, Johnson, Montomery & Iverson (1998), criminal behaviour (Greening, 1997), stress, suicide tendency, desperation and depression (Yang & Clum, 1994), and various psychological problems (Conger, Conger, Edmondson, Tescher & Smolin, 2003). Also, it was found that developed problem solving skills affect individuals' level of self-adjustment (Wong, 1988) and their academic success (D'Zurilla & Sheedy, 1992; Salami & Aremu, 2006) in a positive way. In addition, how individuals perceive their problem solving skills were researched in some studies. This situation is related with the extent to which an individual perceives himself as capable in problem solving. In studies on this issue, it was seen that the higher individuals' perceptions of problem solving skills are, the higher their problem solving skills (Heppner, Witty & Dixon, 2004), their sense of self (Heppner, Reeder & Larson, 1983), their academic success and leadership skills (Ferah, 2000) and their social and personal harmony (Saygili, 2000) are. So, when the results of these studies are examined carefully, it is understood that problem solving skills and the perception of problem solving skills have an important place in individuals' development, and may affect them in a positive or negative way.

Traditionally, problem solving in Mathematics comes to mind when problem solving is mentioned. One of the most important aims of education is to make our students good problem-solvers (Akay, 2006; Baki, 2006; Billstein, Libeskind & Johnny, 2004). Problem solving in Mathematics includes solving simple verbal and unusual questions, applying Mathematics in real-life situations and producing interpretations which may give rise to forming of new fields (Karatas, 2008).

It is aimed in every course of the educational programmes renewed in 2005 that problem solving becomes a common skill among students. In addition, Mathematics is defined as one of the 4 important skills at primary schools from sixth to eighth grades and one of the 6 important skills in secondary schools from ninth to twelfth grades. It is stated that problems to be used in Mathematics education should be relevant to students' lives and they should be interesting in order to facilitate the application of Mathematical skills and knowledge acquired by the student in various situations. When studies on this subject (Akay, 2006; Özsoy, 2005) are examined, it is observed that the emphasis is on this point. Moreover, it is regarded important that there are problems with an open-end, without a common way to solve and which require the use of various knowledge and skills together to reach at a solution. Also, how the learning environment should be organized is explained in detail (Ministry of National Education [MNE] 2005, 2008).

When the data given above is evaluated, it is observed that Mathematics education is supposed to contribute to problem solving skills in real life situations as well. When related literature is studied, Saracaloğlu, Serin and Bozkurt (2002) found out that problem solving skills of students in Department of Psychological Services in Education were higher than those of master and doctorate students in Departments of Science, Physics, Chemistry, Mathematics and Biology. However, it was emphasized that the fact students in Department of Psychological Services in Education got training about problem solving skills might have an effect on this situation. Within the scope of this study, as different from other studies in the literature, it was regarded as important to show the differentiation in perception of the problem solving skills of students who got a more intensive Mathematics education than that of students who got a less intensive Mathematics education.

In the light of this information, the aim in this research was determined as to predict university students' perceptions of problem solving skills from their Mathematical success. To achieve this aim, answers to the following questions were sought.

1. Are students' net Mathematics scores in SSE a meaningful predictor of the points they get in the problem solving inventory?
2. Are scores in the General Mathematics Course taught in primary School Mathematics Teaching Programme a meaningful predictor of the points students get in the problem solving inventory?
3. Do students' points in the problem solving inventory show a meaningful difference according to Mathematical Departments (Primary School Mathematics) and Non-Mathematical Departments (Social Sciences Department and Religious Culture and Moral Knowledge Department)?
4. Do students' points in the problem solving inventory show a difference according to the types of the programme (Primary School Mathematics Teaching, Social Sciences Teaching, Religious Culture and Moral Knowledge Teaching)?
5. Do students' points in the problem solving inventory show a meaningful difference according to gender?

2. Method

Participants

The population of the study consists of a total of 1547 students attending Rize University Faculty of Education, Primary School Mathematics Teaching, Social Sciences Teaching, Religious Culture and Moral Knowledge Teaching, Science Teaching and Primary Teaching Departments in the 2009-2010 academic years.

The sample of this study consists of a total of 284 students from Departments of Primary School Mathematics, Religious Culture and Moral Knowledge and Social Sciences Teaching. The sampling method used in this study is the sampling method that is easily found. This method, as Berg (2001) mentioned, is defined as a sampling method in which people who volunteer to participate or are available to the researcher are taken into the scope of study. The data gathering tool of the research was administered to the students who volunteered to participate in the study. Because the tool could not be administered to students who unwilling to fill in the scale or were not present at that moment, the number of participants were limited to 201 people. 104 of the participants were female and 97 were male in the study in which 110 students from Department of Primary School Mathematics Teaching, 56 from Religious Culture and Moral Knowledge Teaching and 35 from Social Sciences Teaching programmes participated.

Instrumentation

The Problem Solving Inventory: The problem-solving inventory, which was developed by Heppner and Peterson in 1982, was adapted to Turkish by Sahin, Sahin and Heppner in 1993. As a self

evaluation tool, this Likert type inventory is applied to adolescent-adults and measures the self-perception of the problem solving skills of individuals. It consists of 35 items scored from 1 to 6 points. A high level of total points in the inventory indicates that the subject perceives himself/ herself incompetent in problem solving skills. During scoring, the items 9, 22 and 29 are kept out of scoring and some of the items (1, 2, 3, 4, 11, 13, 14, 15, 17, 21, 25, 26, 30, 34) are reverse-scored. The scale can also be used as a total score. The Cronbach's Alpha internal-consistency coefficient was found as .90, .72 and .85 for subscales, respectively. Three factors were observed as a result of the factor analysis; *confidence in the problem solving skill*, *approach-avoidance* and *personal control*. The scale-form was administered to 244 university students and Cronbach's Alfa reliability coefficient was found as .88. The reliability coefficient obtained with the halving-method of odd & even numbered items was found .81. The reliability coefficients obtained from the subscales range from .59 to .78. The correlation ranges between these three factors vary from .38 to .49. Also, the correlation coefficient between the total score in the scale and Beck Depression Inventory is .33 and between STAI-T and the total score is .45 (Savasir & Sahin, 1997).

Data Analysis

As mentioned above, the operations can be carried out on total scores in the scale. Within the scope of the study, analyses were performed on total points. Another point given attention in the analyses was the result from scoring criteria of the scale that the higher point individuals got in the scale the less competent they saw themselves in problem solving skills. Net Mathematics scores that the students in the study answered in SSE were taken from Rize University Student Affairs Office. Students' General Mathematics Course scores were accessed through Faculty of Education Students Affairs Office. The Regression Analysis was applied in order to determine whether students' net Mathematics scores in the SSE (Student Selection Examination) were a meaningful predictor of their points in the problem solving inventory. Besides, The Regression Analysis was used in order to determine whether students' scores in General Mathematics Course taught in Primary School Mathematics Teaching programme were a meaningful predictor of points taken in the problem solving inventory. ANOVA was used to indicate the differentiation of the points scored in the problem solving inventory according to the programmes (Mathematical and Non-Mathematical) and t-test was used to indicate the differentiation of the points scored in the problem solving inventory according Departments (Primary School Mathematics Teaching, Social Sciences and Religious Culture and Moral Knowledge) and gender.

Results

For the purpose of predicting the problem solving skills from net Mathematics scores in the SSE, regression analysis was performed and results of analysis were showed in Table 1.

Table 1. *Predicting the Problem Solving Skills from Net Mathematics Scores in the SSE*

		B	*Std. Error*	*ß*	*t*	*P*
Problem Solving Skills	Constant	4.07	.08		50.19	.00
	Net Mathematics Scores in the SSE	9.04	.00	.00	.04	.97
	R= .00 R^2 = .00	$F(1,199)$ = .00		p= .97		

When Table 1 was examined, it was seen that net Mathematics scores in SSE were not a meaningful predictor of points taken from the problem solving inventory. ($ß$= .00, t= .04, p= .97). Also, a meaningful correlation (r=.00) was not found when correlation coefficients between net Mathematics scores in SSE and points in the problem solving inventory were examined. Therefore, it is understood that students' net Mathematics scores in SSE were not a meaningful predictor of their perceptions of problem solving skills.

For the purpose of predicting the problem solving skills from General Mathematics Course scores, regression analysis was performed and results of analysis were showed in Table 2.

Table 2. *Predicting Problem Solving Skills from General Mathematics Course Scores*

		B	*Std.Error*	*ß*	*t*	*P*
Problem Solving Skills	Constant	4.00	.18		22.42	.00
	General Mathematics Course Scores	.01	.04	.04	.40	.69
	R= .04 R^2 = .00	$F(1,108)$ = .16		p= .69		

When Table 2 was examined, it was noticed that General Mathematics Course scores of students in the Primary School Mathematics Teaching programme were not a meaningful predictor of the points they got in the problem solving inventory. (*ß*=.04, *t*=.40, *p*=.69). Besides, a meaningful relation (*r*=.04) was not found when correlation coefficients between General Mathematics Course scores and points in the problem solving inventory were examined. Therefore, it was seen that General Mathematics Course scores of students in Primary School Mathematics Teaching programme were not a meaningful predictor of their perceptions of problem solving skills.

For the purpose of determining the problem solving skills according to Mathematical and Non-Mathematical programmes, t-test was performed and results of analysis were showed in Table 3.

Table 3. *Differentiation in Problem Solving Skills according to Mathematical and Non-Mathematical Programmes*

Department	*N*	*M*	*Sd*	*Df*	*T*	*P*
Mathematical	110	4.07	.57	199	-.03	.98
Non-Mathematical	91	4.07	.64			

When Table 3 was examined, it was seen that points in the problem solving inventory did not show a meaningful difference according to the Mathematical and Non-Mathematical programmes [t (199) = -.03, $p > .05$].

For the purpose of determining the problem solving skills according to Departments, ANOVA was performed and results of analysis were showed in Table 4.

Table 4. *Differentiation in Problem Solving Skills According To Departments*

Department	*N*	*M*	*Sd*	*df*	*F*	*p*
Primary School Mathematics	110	4.07	57			
Social Sciences	35	4.00	63	200	.34	.71
Religious Culture and Moral Knowledge	56	4.11	65			

When Table 4 was examined, it was seen that points in the problem solving inventory did not show a meaningful difference according to Departments [F (2-198) = .34, $p > .05$].

For the purpose of determining the problem solving skills according to gender t-test was performed and results of analysis were showed in Table 5.

Table 5. *Differentiation in Problem Solving Skills According To Gender*

Gender	*n*	*M*	*Sd*	*Df*	*T*	*P*
Female	104	4.19	.60	199	2.93	.00
Male	97	3.94	.58			

When Table 5 was examined, points in the problem solving inventory showed a significant difference in favour of female students [$t(199) = 2.93$, $p < .05$]. Points of female students ($M = 4.19$) were higher than those of male students ($M = 3.94$).

Discussion

As a result of this study, it is understood that students' net Mathematics scores in SSE is not a meaningful predictor of their perception of problem solving skills. Similarly, it is seen that General Mathematics Course scores of students in the Primary School Mathematics Teaching Programme are not a meaningful predictor of their perceptions of problem solving skills. In their study, Alci, Erden and Baykal (2006) come to the conclusion that Mathematics success is not a meaningful predictor of problem solving skills. The results of this study are in accordance with their results. However, Chang & D'Zurilla (1992), Rodríguez-Fornells & Maydeu-Olivares (2000) and Salami and Aremu (2006) indicate that Mathematics Course success is a meaningful predictor of students' problem solving skills. Results of this study are in conflict with their results. If the content of the General Mathematics Course is examined, it can be seen that the content consists of subjects that are not directly related to problem solving, such as number groups and their specialties, absolute value, complex numbers, functions, series etc. On the other hand, students are asked to find the correct option in SSE in a minimum time due to the exam's structure while there are goals related to problem solving in the Mathematical knowledge to be evaluated in it. It can be said that this situation does not give students the opportunity to internalize their problem solving skills. So, it can be inferred that there are not meaningful relations between problem solving in Mathematics and points in the problem solving inventory which is orientated towards solving problems in daily life.

Points taken in the problem solving inventory are observed to show no meaningful difference when compared according to Mathematical (Department of Primary School Mathematics Teaching) and Non-Mathematical (Social Sciences Department and Religious Culture and Moral Knowledge Department) programmes or according to each individual department. This result is in accordance with the other results found in the study mentioned above. In their studies, Basmacı (1998), Cam (1997), Güven & Akyüz (2001), Görmez (1998) and Serin (2001) showed that students' problem solving skills do not differ meaningfully according their departments. There is no meaningful difference between the students whose education includes more Mathematics and aims to give students problem solving skills and students of other departments. That can be explained by the fact that objectives in the Mathematics teaching program are not fully achieved.

Points of female students got in the problem solving inventory were higher than those of male students. This result is similar to the results of studies done by Gallagher, De Lisi, Holst, McGillicuddy-De Lisi, Morely & Cahalan (1999). On the other hand, Basmacı (1998), Çam (1997), Görmez (1998), Güven & Akyüz (2001), Kasap (1997), Saracaloglu, et el. (2002) and Tümkaya, Aybek, & Aldag (2009) found that problem solving skills did not differ according to gender while Cenkseven & Vural (2006) and Serbin, Sprafkin, Elman ve Doyle (1982) found that female students perceived themselves more competent than male students. So, these results are in conflict with the results of this study.

Conclusion

As a result of the study, it was observed that students' net Mathematics scores in SSE was not a meaningful predictor of their perceptions of problem solving skills. Similarly, it was concluded that General Mathematics Course scores of students in the Primary School Mathematics Teaching programme were not a meaningful predictor of their perceptions of problem solving skills. Points in the problem solving inventory showed no meaningful difference according to departments and programmes while they showed a meaningful difference in favour of female students.

In secondary school Mathematics education, it is possible to form more settings where students can internalize problem solving processes and associate these problems with real life situations and project works with other assignments can be given to students to ensure that goals. Also, it will be useful to do works which can help students develop their problem solving skills and relate course subjects to real life during General Mathematic Course at the university. In an experimental study by Akay (2006) on the subject, it is found that Mathematics teaching carried out with the problem setting approach has a positive effect on students' academic success and their problem solving skills. Therefore, it is considered to be useful to pay attention to these points during the Mathematics teaching process.

Within the scope of individual and group psychological counseling therapy about developing problem solving skills; students can be helped by discovering their efficient and inefficient sides and by

different activities. When studies on this subject are examined, it is observed that problem solving skills can be improved with various training activities (Cam, 1997; Yildiz, 2003).

In this way, they can be contributed to their personal development. This study can be carried out in more different programmes in Faculty of Arts and Sciences (Mathematics, Biology, Chemistry, Physics, Psychology, Sociology, Philosophy History and Geography) and in different university. By this way, generalizability of the findings derived from the study can be increased.

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