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THE RELATIONSHIP BETWEEN 7th AND 8th GRADE STUDENTS' CONCEPTUAL LEARNING AND MATHEMATICS SELF-EFFICACY LEVELS OF SUBJECT OF "ALGEBRAIC EXPRESSIONS AND EQUATIONS"

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ABSTRACT

The aim of this research is to determine the correlation between 7th and 8th grade students' conceptual learning and mathematics self-efficacy in 'Algebraic Expressions and Equations' subject. The study was carried out in a public school on the Anatolian side of the city of Istanbul in 2011-2012 academic years. The study was conducted with 97 students in total and 47 of them are 8th grade and 50 of them are 7th grade students. The research model of the study is screening model. The data of the study was collected through 'Conceptual Understanding Test regarding Algebraic Expressions and Equations [CUTAEE]' and 'Self-efficacy Perceptions towards Mathematics Scale [SPMS]'. The data of the study was analyzed by using qualitative and quantitative methods. Frequency (f) and percentages (%) were used for quantitative methods. The data obtained through CUTAEE was evaluated with content analysis. According to the obtained findings, it was determined that there was a significant and positive correlation between the mathematics self-efficacy levels of the students and the concepts regarding 'Algebraic Expressions and Equations' subject of the 7th and 8th grade students. Besides, while a significant difference was found in favor of 8th grade students in terms of students' conceptual understanding, there was not a significant difference between the mathematics self-efficacy levels of the 8th students. In terms of genders, it was determined that there was a positive and significant correlation in favor of male students between both mathematics self-efficacy and conceptual understanding levels of 7th and 8th grade students. The suggestions were made in accordance with the obtained findings.

Keywords: Conceptual learning, mathematics self-efficacy, algebraic expressions, equations.

INTRODUCTION

The primary and middle schools have great importance since they have preparatory roles in terms of constructing the basic scientific information for the higher levels of education. Starting from the first years, well-constructed mathematics information is among the subjects that are needed to be carefully considered since it is the pioneer of the students' future academic achievements. According to Hung (2000), mathematics is a whole of systems which is based on thinking skills which are composed of conceptual structures and is a thinking style which uses intuition and mental presentation of the information. In order to understand mathematics, it is necessary not only to apply algorithmic rules but also to acquire the conceptual learning dimension by discussing the information (Davis, 1992).

Concepts are mental tools which ensure people to classify and organize the things they have learnt by constructing the basics of information. Kaptan (1998) defines concept as the common name which is given to the group of ideas, objects and events which have similar features and Senemoğlu (2005) defines it as a category which is used in grouping similar objects, people, events, ideas and processes. In other words, concepts provide individuals to classify and organize the things they learnt. Individuals starting from their childhood years classify the concepts by actively learning them, constantly organize them by giving new meaning to learnt information and even produce new information and concepts (Cansüngü Koray & Bal, 2002). For this reason, concepts have an important place in understanding and sensing the meaning of the world, concepts constitute the basic units of information and the conceptual relationships create the scientific structures.

It is not enough to make definitions and to give examples for creating and learning concepts. In addition to that, it is necessary to be able to determine the critical points regarding the concept, to state the main characteristics, to relate concepts with everyday life, to make connections with other concepts and sub-concepts and to specify clearly the common and different features between various concepts (Alkan & Uğurel, 2004), as the knowledge of a concept is chained to one another with the relations of a wide variety of different concepts. If we associate the knowledge of a concept to a chain's ring, then each ring will contain some information. As the inter-connected knowledge expands, the ring of the chain to which the concept is bounded will also expand so that the information piece to which it is connected will become stronger (Baki & Kartal, 2002). On the contrary, if we consider the fact that mathematics subjects are in the form of a helical structure, the lack of information in the pre-concepts will hinder the students' meaningful structuring processes on the next levels. It can be said that this case will be effective on the perceptions of students as 'I do not understand mathematics and I cannot do it'. Besides, it is thought that it can have negative reflections on the points of students' self-confidence and organizing an activity which is necessary for students to display a performance regarding mathematics and successfully accomplished it. The findings of the study which was carried out by Randhawa, Beamer and Lundberg in 1993 also show that mathematics self-efficacy is an important variable between the attitudes towards mathematics and mathematics achievements.

When students engage into a certain learning process, the source of their efforts will be composed of their interests, attitudes and beliefs to become successful in this process. According to Bloom (1998) affective domain components (interest, attitudes etc.) have power to explain the 25% of the change in learning products. This shows the fact that one fourth of the difference between the learning of individuals is derived from these affective features. In addition to this, the belief of self-efficacy is an effective precursor on the mathematics achievements of the individuals (Kiemanesh, Hejazi & Esfahani, 2004). According to Zimmerman, Bandura and Martinez-Pons (1992), self-efficacy and using strategies explain the 30% of the variability in academic achievement.

Hackett and Betz (1989) define self-efficacy towards mathematics as 'believing your own skills to successfully accomplish the tasks regarding mathematics'. In the studies about this subject, many researchers have analyzed the correlation between mathematics self-efficacy and various variables (mathematics achievement, mathematics attitude, mathematics concerns, interests to lessons related with mathematics and choosing occupation related with mathematics). In many studies which searched the mathematics self-efficacies, it was found that there was a significant correlation between students' mathematics achievements and their self-efficacies (Chen, 2002; Hackett & Betz, 1989; Migray, 2002; Moore, 2005). When the direction of this correlation was examined, it was presented that it was a negative correlation with concerns regarding mathematics and a positive one with mathematical performances (Cooper & Robinson; 1991) and also it was found out that mathematics self-efficacy was an important variable between attitudes towards mathematics and mathematics achievement (Hackett & Betz, 1989; Randhawa, Beamer & Lundberg, 1993), besides mathematics self-efficacy had an important intermediary role in the process of choosing an occupation regarding mathematics (Betz & Hackett, 1983; Hackett, 1985).

The mathematical concepts are abstract and it is not easy to learn and to construct them properly. It is especially important in this point to present the level of mathematics self-efficacies of students and

mathematical subjects in which the students have a lot of misconceptions. The 'Algebraic Expressions and Equations' subject in 'Algebra' sub-learning field stated in the 7th and 8th grades of the middle school mathematics program has an important place in terms of making students develop a positive attitude towards mathematics. Because algebra is an important learning field which has an important role in improving mathematical thinking and is a mathematical language which expresses itself with symbols, tables, words and graphics (Stacey & MacGregor, 2000). Accepting algebra as a language shows how important is to teach algebra for understanding mathematics (Williams & Molina, 1997). Students should understand the letters which are used in different situations in algebra, the structural features of the algebraic equations, symbols for interpreting the equations given in case of equation and solving the equations and operations carried out symbols (Kieran, 2007). Kieran (2007) puts understanding and using symbols and mathematical understanding into the centre of the algebraic thinking. For this reason, the purpose of this study to determine whether there is a correlation between 7th and 8th grade students' conceptual learning and mathematics self-efficacy in 'Algebraic Expressions and Equations' subject and to present this correlation after analyzing it according to different variables and also the answers of the following questions are searched;

1. Is there a significant difference between the conceptual learning levels of 7th and 8th grade students?
2. Is there a significant difference between the mathematics self-efficacy levels of 7th and 8th grade students?
3. Is there a significant correlation between students' mathematics self-efficacies and their conceptual learning together with sub-dimensions of the self-efficacy scale?
4. Are mathematics self-efficacies of students a significant predictor of their conceptual learning?
5. Is there a significant difference between students' conceptual learning and their mathematics self-efficacies by their genders?

METHOD

Research Design

This research is a descriptive study which was carried out with relational screening model. The relational screening models are research models that are trying to determine the presence of the change or the degree of change between two or more variables. The purpose of description in this model is to determine the discriminations between cases such as individuals and objects rather than finding the size of something present which fits to certain standards. The correlations found through screening cannot be interpreted as a real cause and effect relationship; but they can give useful results in predicting the other one by giving some clues towards that direction if the case in a variable is determined (Karasar, 2003).

Study Group

The study group of the research is consisted of a class of 7th grade and a class of 8th grade students who were randomly selected from a public middle school in the Anatolian side of Istanbul in 2011-2012 academic years. In the study group there 20 female and 27 female in total 47 8th grade students and 22 female and 28 male in total 50 7th grade students. In this sense, this study was carried out with 97 students.

Data Collection Tools and Collecting Data

Two assessment tools were used in this study. The first one was 'Conceptual Understanding Test regarding Algebraic Expressions and Equations [CUTAEE]' which was prepared about 'Algebraic Expressions and Equations' subject. CUTAEE is a test which is consisting of 13 open-ended questions which was created as result of the classification of the concepts selected according to the objectives related with the 'Algebraic Expressions and Equations' subject. It was paid attention to create questions in way to determine whether students have misconceptions, whether they created correlations between concepts and whether they learnt the concepts meaningfully. For the items used in the assessment tool, opinions of the 2 experts in the subject area and 2 academicians were taken before the implementation. First of all, in order to specify the content validity, it was asked to experts whether the questions used in the assessment tool represent the considered objectives in the different types of 'Algebraic Expressions and Equations' subject defined in related literature. Besides, the items in the assessment tool was analyzed by experts for understanding whether they were expressed properly, their level of difficulty, whether they could cause misunderstandings and to what extent they test the thing that they wanted to assess.

The consensus in the evaluations of the expert and academician was calculated by using the following formula stated in Miles and Huberman (1994): *'Agreement Percentage=Agreement/(Agreement+Disagreement) x 100'*. As a result of this calculation, the consensus percentage was found as ,91. In addition to that, a pilot study was carried out to guarantee that the time allocated for the test was suitable and whether the items of the test were clear or not with 15 8th grade and 10 7th grade students who can be compared with the general academic backgrounds of the participants in a broader study. The test was taken its final form by making the necessary editions as a result of the opinions of the experts and the pilot study.

The second assessment tool was 'Self-efficacy Perceptions towards Mathematics Scale [SPMS]' which was developed by Umay (2002) in order to test the students' self-efficacy perceptions towards mathematics. In likert type scale there are 8 positive (1, 2, 4, 5, 8, 9, 13, 14) and 6 negative (3, 6, 7, 10, 11, 12) in total 14 items. The items of the scale were scored as; never (1), rarely (2), sometimes (3), generally (4) and always (5). Besides, the scoring was conducted in reverse for the negative items. The scale is consisted of three factors. These factors were defined as 1) mathematics self-esteem, 2) the awareness at the behaviors in mathematics subjects and 3) the ability to convert mathematics into life skills. The first factor is installed in the 3rd, 10th, 11th, 12th, and 13th items; the second factor in 4th, 5th, 6th,7th, 8th and 9th items; the third factor in 1st, 2nd, and 14th items. The alpha reliability coefficient of the scale was calculated as α= 0,88 for the total. The alpha reliability coefficient of the scale was determined as α= 0,70 for this study, the alpha reliability coefficient for the sub-factors was found respectively for the first factor as α= 0,58; for the second factor as α= 0,59 and for the third factor as α= 0,61.

The implementation was carried out in different days with 7th and 8th grades. First of all, CUTAEE was conducted with 7th grades in two lessons. Later on, they were asked to fill in SPMS. 25 minutes were given to students for this. The same procedure was repeated with the 8th grade students.

Data Analysis

The answers of the each student that they gave for the question in CUTAEE were analyzed one by one and classified under five categories. Furthermore, each of these categories was evaluated in four different ways by dividing into sub-units. The evaluation form can be seen Table 1.

Table 1: Categories and Sub-units

The definition of equation and knowing the definitions of the types of equations and giving example	
There is a definition and there is an example	3 points
There is a definition but there is not an example	2 points
There is not a definition but there is an example	1 point
There is not a definition and there is not an example	0 point
Explaining the correlation between equality and inequality with its reasons	
Know the correlation between concepts, know the reason	3 points
Know the correlation between concepts but do not know the reason	2 points
Do not know the correlation between concepts but know the reason	1 point
Do not know the correlation between concepts and do not know the reason	0 point
Be able to express the given problems on figures mathematically	
There is visualization and interpretation	3 points
There is visualization without interpretation	2 points
There is no visualization but there is interpretation	1 point
There is no visualization and interpretation	0 point
Analyzing the direct correlation between two variables by using tables and graphics and interpreting the figure	
There are tables and graphic with reasons	3 points

There are tables and graphics without reasons	2 points
There are no tables and graphics but there is a reason	1 point
There are no table and graphics and there is no reason either	0 point
Making calculations with algebraic expressions and interpreting that operations	
There is a calculation with an interpretation	3 points
There is a calculation without an interpretation	2 points
There is no calculation but there is an interpretation	1 point
There is not calculation and interpretation	0 point

The maximum score one can get from CUTAEE is 39. On the other hand, necessary analyses were carried out by evaluating the data obtained from the assessment tools through statistical analysis method. During the data analysis, correlation, regression and t-test statistical operations were used.

FINDINGS AND COMMENTS

In this part, findings obtained from research questions for the 7th and 8th grade students' conceptual learning and mathematics self-efficacies are presented respectively. The results appeared as result of the data analysis regarding the first sub-problem of the study are given in Table 2.

Table 2: t-test Results Regarding the CUTAEE Scores of the 7th and 8th Grade Students

Grade Level	N	$\overline{X}$	sd	df	t	p
7th grade	50	23,23	4,983	95	2,259	0,026
8th grade	47	25,62	5,394			

When Table 2 is analyzed, it is seen that 7th grades' conceptual learning arithmetic mean is 23,23, standard deviation is 4,983; 8th grades' conceptual learning arithmetic mean is 25,62 and standard deviation is 5,394. As a result of the t-test carried out for the conceptual learning of the 7th and 8th grades, a significant difference at ,05 significance level was found. It was seen that in t–test conducted for 7th and 8th grade students, there was a statistically significant difference between conceptual learning of the students at ,05 level in favour of 8th grade students [t(95)= 2,259; p < ,05]. According to this finding, it can be said that 8th grade students structured the concepts related with the 'Algebraic Expressions and Equations' subject better. It can be said that this is a result of the teaching in 8th grade level which is based on the concepts learnt in 7th grade and 8th grade students' effort to correlate that concepts with new ones by re-questioning the same concepts. The results appeared as result of the data analysis regarding the second sub-problem of the study are presented in Table 3.

Table 3: t-test Results Regarding Mathematics Self-efficacy Scores of 7th and 8th Grade Students

Grade Level	N	$\overline{X}$	sd	df	t	p
7th grade	50	50,446	9,131	95	0,327	0,744
8th grade	47	51,020	8,112			

When Table 3 is analyzed, it is seen that 7th grades' mathematics self-efficacy arithmetic mean is 50,446, standard deviation is 9,131; 8th grades' mathematics self-efficacy arithmetic mean is 51,020 and standard deviation is 8,112. As a result of the t-test carried out for the mathematics self-efficacy of the 7th and 8th grades, a significant difference at ,05 significance level was not found. It can be said that 7th and 8th grade students are equal to each other in terms of their mathematics self-efficacies [t(95)= 0,327; p > ,05]. Although there was not a significant correlation here, when their mathematics self-efficacy averages are considered, it can be said that 8th grade students' mathematics self-efficacy average score is higher that 7th grades. The results appeared as result of the data analysis regarding the third sub-problem of the study are presented in Table 4.

Table 4: The Correlation between Students' Self-efficacy Scores and Conceptual Learning

	R	p	N	Value
Slf-Ef./ CUTAEE	0,767	,000	97	p < ,05
Slf-Ef. 1st Dimension / CUTAEE	0,538	,000	97	p < ,05
Slf-Ef. 2nd Dimension / CUTAEE	0,520	,000	97	p < ,05
Slf-Ef. 3rd Dimension / CUTAEE	0,417	,000	97	p < ,05

When Table 4 is analyzed, a high level, significant and positive correlation is seen between the students' self-efficacies and their conceptual learning (R= ,767; p < ,05). According to this, it can be said that students who have high level mathematics self-efficacies have also high level conceptual learning. Büyüköztürk (2012), defines the case as a high level correlation when the correlation coefficient is between 0,70-1,00 as an absolute value and when it is between 0,70-0,30 as a middle level correlation. The results appeared as result of the data analysis regarding the fourth sub-problem of the study are presented in Table 5.

Table 5: The Regression Analysis about Predicting Students' Conceptual Learning according to Their Self-efficacies

Slf-Ef./ CUTAEE	B	St. Error B	Beta	t	p
Fixed	20,425	2,664	---	7,677	,000
CUTAEE	1,239	0,106	0,767	11,643	,000
R = 0,767 R^2 = 0,588 F(1-95) = 135,557 p = ,000 p < 0,05					
Slf-Ef. 1st Dimension / CUTAEE	B	St. Error B	Beta	t	p
Fixed	0,987	1,563	---	6,275	,000
CUTAEE	0,388	0,062	0,538	6,220	,000
R = 0,538 R^2 = 0,289 F(1-95) = 38,688 p = ,000 p < 0,05					
Slf-Ef. 2nd Dimension / CUTAEE	B	St. Error B	Beta	t	p
Fixed	9,980	1,806	---	5,527	,000
CUTAEE	0,428	0,072	0,520	5,935	,000
R = 0,520 R^2 = 0,270 F(1-95) = 35,219 p = ,000 p < 0,05					
Slf-Ef. 3rd Dimension / CUTAEE	B	St. Error B	Beta	t	p
Fixed	5,838	1,159	---	5,037	,000
CUTAEE	0,207	0,046	0,417	4,466	,000
R = 0,417 R^2 = 0,174 F(1-95) = 19,946 p = ,000 p < 0,05					

According to the results of the regression analysis given in Table 5, it is seen that students' mathematics self-efficacies are important predicators of their conceptual learning (R = 0,767; R^2 = 0,588; F(1-95) = 135,557; p < ,05). On the other hand, when an analysis is carried out in terms of sub-dimensions of the self-efficacy scale, it can be said that the self-efficacies of the students that they developed for the so-called lesson is an important predicator of both 'mathematics self-esteem', 'the awareness at behaviors in mathematics subjects' and 'the ability to convert mathematics into life skills'. The results appeared as result of the data analysis regarding the fifth sub-problem of the study are presented in Table 6.

Table 6: t-test Results for the Difference between Students' Self-efficacy Scores and Their Conceptual Learning Scores by Gender

Gender & Self-Efficacy	N	$\overline{X}$	sd	df	t	p
Male	55	55,33	7,418	95	7,595	,000
Female	42	47,74	5,897			
Gender & Concept	N	$\overline{X}$	sd	df	t	p
Male	55	26,84	4,633	95	5,840	,000
Female	42	21,36	4,503			

According to Table 6, there is significant difference between students' mathematics self-efficacy levels (t(97)= 7,595; p < ,05) and their conceptual learning (t(97)= 5,840; p < ,05) by their genders and this difference is in favor of male students. In addition to that the effect sizes were also calculated together with all the relational analysis results. Because with the conducted t-test whether there is a significant difference or not is presented but it does not inform us about the size of the difference (Şengül & Dereli, 2013). For this reason, it is important to know the effect size as well as the statistical significance (Morgan, Leech, Gloeckner & Barrett, 2004). According to Cohen (1988) if ,01< $ç^2$ < ,06 then the effect is small, if ,06≤ $ç^2$ < ,14 then the effect is average, if ,14≤ $ç^2$ then the effect is big. The effect size is 0,37 for the gender and mathematics self-efficacy so the effect size is big. According to this, it can be said that 37% of the variance observed in mathematics self-efficacy score depends on the gender. The effect size is 0,26 for the gender and conceptual learning so the effect size is big. According to this, it can be said that 26% of the variance observed in conceptual learning score depends on the gender.

CONCLUSION, DISCUSSION AND IMPLICATIONS

According to the research finding, it was appeared that the conceptual learning of 8th grade students is higher than 7th grade students. This finding shows us that as the grade level of students goes up, their conceptual learning also increases. It can be said that this result supports the opinion of Ausubel (1968) that knowledge is a cumulative process. It is also important in terms of showing the fact that pre-information should be properly constructed in conceptual learning.

A significant and positive correlation was found between students' mathematics self-efficacy belief scores and their conceptual learning scores. In addition to that it was determined that students' self-efficacy is an important predicator of their conceptual learning. This finding shows parallelism with the dimensions such as 'mathematical self-esteem', 'the awareness at the behaviors in mathematics subjects' and 'the ability to convert mathematics into life skills' which are the components of the conceptual achievement self-efficacy scale. This finding of the study supports the opinions of Kiemanesh, Hejazi and Esfahani (2004) that the belief of self-efficacy is also an effective precursor of the people's mathematical achievements. Thus it is important to have students see mathematics as 'perceivable, useful and worth dealing with' and to provide them learning environments which will help them to study carefully and diligently. As conceptual learning and communicating by using mathematical knowledge are supported at the program of teaching mathematics in middle schools (MEB, 2012), it is also thought that it is effective to give importance to let students abstract, make correlations and infer mathematical understandings with the help of concrete experiences and to create learning environments in accordance with this purpose.

Although self-efficacy levels of 8th grade students were higher, a statistically significant difference could not be found between the self-efficacy levels of 7th grade students and theirs. This finding shows parallelism with the opinion of Israel (2007, pp. 38) that ' the students who perceive themselves as insufficient on certain occasions can get success by setting goals for themselves and putting more efforts even though they do not have self-confidence. Although self-efficacy, which is a belief, is directly related with the idea of 'I am going to be successful', it is not exactly related with having skills, experiences, understandings and information which are necessary for being successful'.

The study presents that the levels of both conceptual learning and mathematics self-efficacy of male students are higher than female students. It is thought that male students have more tendencies to choose a profession which depends on numerical studies then female students as a result of the effective role of mathematics self-efficacy in choosing a profession and the level of mathematics self-efficacy to predict mathematical concepts is effective in obtaining these findings (Şengül, 2011). This finding of the study support the results of the studies carried out by Betz and Hackett (1983) and Taşdemir (2012).

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