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The relationship between secondary school students' arithmetic performance and their mathematical literacy

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Abstract

The purpose of the present study was to explore the relationship between seventh grade secondary students' arithmetic performance and their mathematical literacy. The study group was comprised of 297 students, selected via random sampling from among seventh grade students enrolled in Zübeyde Hanım Secondary School in Serdivan, Sakarya during the 2012-2013 and 2013-2014 academic years. The relationship survey, a quantitative research model, was employed in the study. The data collection instruments utilized in the study were the Arithmetic Tempo Test (Tempo Test Rekenen, TTR; De Vos, 1992), which was used to test students' arithmetic performance, and sample 7th grade PISA questions published by the Ministry of National Education (MoNE), used to measure mathematical literacy. The statistical analyses yielded a moderate level of relationship between mathematical literacy and arithmetic performance levels.

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1. Introduction

Within the last quarter of the century, during which science and technology have undergone rapid development, the education systems of a vast majority of countries have included among their goals the target to educate individuals that are qualified in all respects and highly successful in order to catch up with powerful countries in the world (Akyüz & Pala 2010). To this end, individuals need to be educated to become autonomous beings, to acquire the skills to seek and find the information they need, and to adopt self-regulated learning when necessary. The

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expectation for individuals to possess these qualities has increased the importance attached to the frequently mentioned "literacy" ability in recent years.

The topic of mathematic literacy was first taken up in the U.S.A. in the 1980s. There were serious concerns in relation to mathematical ignorance and lack of computing ability in the U.S.A. As a response to these concerns, the National Council of Teachers of Mathematics (NCTM) developed "educational programs and assessment" standards for mathematics education (Martin, 2007). Based on these standards, the National Research Council (NRC) defined mathematics as the key to opportunities and as a result of these standards, it was at the end of the 1990s when mathematics literacy was first expressed within such a wide scope as a goal of mathematics education (Pugalee, 1999). In the copies of NCTM, there are strong views indicating that to realize mathematical literacy, an individual should develop mathematical skills, a unique cognitive attitude towards mathematics and self-confidence in mathematics performance (the so-called mathematical structure of the mind) (Kaiser ve Willander, 2004).

Within the standards of School Mathematics, NCTM defines mathematical literacy as "mathematical knowledge used functionally in many different situations and conditions" (Pugalee, 1999). (Cited in Yenilmez & Uysal 2011). Mathematical literacy was defined by the Organization for Economic Co-operation and Development (OECD) as students' ability to apply their knowledge in the subject area and to apply their ability to reason, analyze and synthesize to the problems they encounter (Sarı Uzun, Yanık, Sezen 2012). As numerous countries give importance to mathematical literacy and are concerned about their place in various types of literacy, OECD initiated the implementation of tests measuring mathematical and science literacy every three years to 15-year-old students who have completed their compulsory education. This is an indication of the degree of importance attributed to literacy at the international level.

In the studies of the Programme for International Student Assessment [PISA], carried out by OECD, mathematics is taken beyond school mathematics by presenting questions based on the context of real life problems rather than the mathematics curriculum. The goal of PISA is to raise individuals who engage in and understand mathematics, who can make sound criticisms and who can use these skills in their future daily and work lives. PISA proceeds with their studies in line with these goals (Kaiser ve Willander, 2004).

The first step for an individual to become mathematically literate is to possess arithmetic skills. When the literature is examined, it is observed that that there are tests developed to measure students' arithmetic speed and skills. Some of these tests can be listed as the Arithmetic Tempo Test (ATT), the Arithmetic Number Facts Test (Tempo Test Rekenen, TTR; De Vos, 1992), and the Arithmetic Test Revised (Kortrijkse Rekentest Revision, KRT-R; Baudonck et al., 2006). Such tests, which have not yet started to be developed in Turkey, show the extent to which students have developed basic arithmetic skills.

It is claimed that students' having good and sound fundamental arithmetic skills is an important predictor in terms of their future school lives and mathematical procedures. Based on the results of the Arithmetic Tempo Test administered to primary school students in the Netherlands, students' norms were identified according to their grade levels, and students passed on to the next stage according to their scores (Stock, Desoete & Roeyers, 2009).

Parallel to these developments that took place in other countries, reforms have been made in education programs in Turkey in the last decade. A student-centered system has been adopted in mathematics education programs with specific emphasis laid upon skills such as seeking cause-effect relationships and making predictions and interpretations. With this system, students are expected to combine their present arithmetic computation skills and mathematical knowledge with interpretation and prediction skills and reach the level of competence of analysis and synthesis. And this makes us conduct research studies on the arithmetic skills that play a fundamental role in the process that leads students to mathematical literacy.

2. Method

In the present study, investigations were conducted to seek the answer to the research question, "What kind of a relationship is there between Students' Arithmetic Performance Scores and their Mathematical Literacy Scores?"

2.1. Participants

The participants of the study were comprised of 297 seventh grade students, 145 (48.8%) of whom were females and 152 (51.2%) of whom were males, enrolled in a school in Serdivan, Sakarya during the 2012-2013 and 2013-

2014 academic years.

2.2. Instrument

The Arithmetic Tempo Test (ATT) and the Mathematical Literacy Tests were administerd to the students to collect the data of the present study. ATT, utilized to determine students' arithmetic performance scores, is comprised of a total of 200 questions which need to be completed in 5 minutes. It includes five sections with 40 questions in each section: a one-minute addition test (Att1), a one-minute substraction test (Att2), a one-minute multiplication test (Att3), a one-minute division test (Att4) and a one-minute mixed computations test (Att5). The Test's Cronbach Alpha coefficient, Guttman Split-Half coefficient, and Spearman-Brown coefficient are .90, .93 and .95, respectively (Desoete, Stock, Roeyers, 2009). To measure students' mathematical literacy, the researchers administered a test that they prepared by selecting sample PISA questions, published by the Ministry of National Education, compatible with seventh grade mathematics education program. The questions were retrieved from http://pisa.meb.gov.tr/wp-content/uploads/2013/07/PISA-kitab%C4%B1.pdf.

2.3. *Data Analysis*

The data were analysed using the SPSS 18.0 statistical package. The results of the study were obtained by means of the Pearson Correlation Coefficient, One Way Analysis of Variance (ANOVA), and Related Samples t-test analyses. The statistical analyses were run at a significance level of 0.05. To analyse students' Mathematical Literacy test results, the arithmetic means and standard deviations were calculated and the necessary analyses were conducted by defining one standard deviation below the mean as low, one standard deviation above the mean as high and the middle group as average level.

3. Findings

Findings related to the relationship between students' mathematical literacy scores and arithmetic performance scores are presented in Table 3.1.

Tablo 3.1 The relationship between students' literacy scores and ATT total score

		ATT Total Score
Literacy	r	.450
	p	.000
	N	283

When Table 3.1 is examined, it can be observed that there is a significantly moderate positive correlation between students' literacy scores and ATT total scores ($r = .45$, $p < .01$). In this case, the higher students' ATT scores, the higher their literacy scores are.

The results of the ANOVA test, conducted to investigate whether students' arithmetic performance scores varied across different mathematical literacy levels (low, average, high), are presented in Table 3.2.

Table 3.2 ANOVA test results of students' arithmetic performance scores in relation to their literacy levels

		Sum of Squares	**sd**	**Mean Square**	**F**	**p**	**Literacy Levels**	**ATT Average Score**	**Significant Differences**
ATT	Between groups	10056,595	2	5028,297	29,000	,000*	Low	49.32	L-A
	Within groups	48549,264	280	173,390			Average	60.53	L-H
	Total	58605,859	282				High	67.90	A-H

*p<.01 L:Low, A:Average, H:High

Table 3.2 indicates a statistically significant variance between students' mathematical literacy and their Arithmetic Performance Scores according to the ANOVA test results [F(2.280)=29.00; p<.01]. Based on these results, it can be concluded that the higher the students' literacy levels, the higher their arithmetic performances are.

After the ATT was administered to seventh grade students during the 2012-2013 academic year, the same test was administered again to the same students in the 2013-2014 academic year. The Test1 and Test 2 results obtained from these test administrations are presented in Table 3.3 below.

Table 3.3 The Relationship between Students' Test 1 and Test 2 Scores of the ATT

	Group	N	$\overline{X}$	Ss	sd	t	p
ATT1	Test 1	134	14.65	2.851	266	-1,971	,050
	Test 2	134	15.33	2.790			
ATT2	Test 1	134	12.228	2.6920	266	-,476	,635
	Test 2	134	12.388	2.8275			
ATT3	Test 1	134	12.38	3.216	266	-2.318	.021
	Test 2	134	13.35	3.572			
ATT4	Test 1	134	9.19	4.006	266	-2.340	.020
	Test 2	134	10.44	4.711			
ATT5	Test 1	134	11.94	2.909	266	-2.557	.011
	Test 2	134	12.90	3.222			
Total Score	Test 1	134	60.384	14.0420	266	-2.236	.026
	Test 2	134	64.399	15.3253			

When the data in the Table are examined, a significant relationship can be observed between Test 1 and Test 2 scores, except for the ATT2 ($p > .05$) score and the limited relationship in ATT1. Accordingly, it can be said that the time period between the two tests had an impact on students' Arithmetic Performance Scores.

4. Discussion

Based on the significant relationship found between students' mathematical literacy scores and their ATT scores, it can be concluded that students with a high level of skills in the four operations may also have a high level of mathematical literacy. Because an important portion of the four computation skills is learned at primary school and since simple mathematical problems are again encountered at primary school level, it can be said that a good and sound primary school education can have crucial impacts on students (Kaiser ve Willander, 2005).

According to the NCTM (2007) standards, it is believed that as students proceed from 3rd grade to 5th grade in primary school, if they develop a method to easily solve and practice operations after they learn arithmetic operations, this will make a great contribution to their mathematical achievement (Kara, 2013). The significant relationship found between ATT scores and literacy scores in the present study can indicate that this view will have a positive impact on mathematical literacy.

As result of the ANOVA test conducted to seek whether students' ATT scores varied across mathematical literacy, significant differences were found between average and low levels, and between average and high levels. This shows that the Arithmetic Tempo Test is predictive of students' mathematical literacy. As in the Netherlands, establishing student norms according to grade levels and implementing the Arithmetic Tempo Test can yield information about students' future mathematical literacy in Turkey (Desoete ve diğerleri, 2009). This application will save time, when compared to the other tests measuring mathematical literacy, and positive outcomes can be achieved in a short period of time.

That the results of the ATT, which was administered to students in the 2012-2013 and 2013-2014 academic

years, yielded significant relationhsips between all ATT scores, except for the Att2 score, may indicate that the time interval between the two implementations constitutes a condition in favour of students' mathematical skills. The reason why no significant relationship was found in the Att2 score can be attributed to small sample size. Considering that the participants of the present study are 7th grade students, the significant results yielded in the study can show that more striking results can be obtained in the primary school stages, where students' individual differences are believed to be more distinct, and thus every period of time students spend at primary school is highly crucial (Çelik & Kandır, 2013).

To increase students' Arithmetic Performances, students should be introduced to mathematics at an early age and during their primary school education, students should initially be educated to understand the logic of mathematical operations and then practice operations through practical means (such as Mental Arithmetics) (Lean ve Lan t.y., Kara, 2013).

To increase students' Mathematical Literacy, students should, as of primary school, be presented with real life problems and open-ended interpretation problems and enable them to approach problems with a critical perspective. Another step that can be taken in this area is to raise qualified primary school teachers, mathematics teachers and science and technology teachers, who are engaged in mathematics (Ersoy,1997;2003).

References

Akyüz ,G. , Pala, N.M. (2010). Pisa 2003 Sonuçlarına Göre Öğrenci ve Sınıf Özelliklerinin Matematik Okuryazarlığına ve Problem Çözme Becerilerine Etkisi [The Impact of Student and Class Characteristics on Mathematical Literacy and Problem Solving Skills]. *Elemantary Education Online 9(2), 668-678, 2010.*

Aztekin, S.,Yılmaz, H.B. (t.y). Türkiye'deki 15 Yaş Grubu Öğrencilerin Matematik Okuryazarlığı Başarılarını Etkileyen Bazı Faktörlerin Okul ve Öğrenci Düzeyine Göre İncelenmesi [The Exploration of Some Factors Influencing the Mathematical Literacy of 15-year-old Students in Turkey in relation to Grade Level and Levels of Students.]

Bindak, R. , Özgen, K. (2011). Lise Öğrencilerinin Matematik Okuryazarlığına Yönelik Öz-yeterlik İnançlarının Belirlenmesi [Detection of High School Students' Self-Efficacy Beliefs in Mathematical Literacy]. *Kuram ve Uygulamada Eğitim Bilimleri [Educational Sciences in Theory and Application]-11(2), Spring, 1073-1089, 2011*

Çelik, M. , Kandır, A. (2013). 61-72 Aylık Çocukların Matematik Gelişimine 'Küçük Çocuklar İçin Büyük Matematik' Eğitim Programının Etkisi [The Impact of the Education Program-Big Math For Little Kids], *Kuramsal Eğitim Bilim Dergisi [Theoretical Educational Sciences Journal]-6(4), 551-567, October 2013*

Desoete, A., Roeyers, H., Stock, P. (2009). Predicting Arithmetic Abilities- The Role of Preparatory Arithmetic Markers and Intelligence. *Journal of Psychoeducational Assessment ,27,(3), 237-251, June 2009.*

Ersoy, Y. (1997). Okullarda Matematik Eğitimi [Mathematics Education at Schools], *Hacettepe University, Eğitim Fakültesi Dergisi [Educational Faculty Journal] 13,115-120,1997*

Ersoy, Y. (2003). Teknoloji Destekli Matematik Eğitimi-1 [Technology Aided Mathematics Education-1]*: Gelişmeler, Politikalar ve Stratejiler, İlköğretim [Developments, Policies and Strategies, Primary Education]-Online 2(1), s. 18-27, 2003*

Kaiser, G. , Willander, T. (2005). Development of Mathematical Literacy: Results of an Empirical Study. , *Teachıng Mathematıcs And Its Applıcatıons Volume 24, No. 2-3, 2005.*

Kara, A. (2013). Abaküs Mental Aritmetik Eğitimi Yaratıcı Düşünme Programının Matematiksel Problem Çözme Becerilerinin Geliştirilmesine Etkisi [The Impact of Abacus Mental Arithmetic Education Creative Thinking Program upon Mathematical Problem Solving Skills], *An Unpublished Master's Thesis, Balıkesir University, Balıkesir.*

Lean, C.B. , Lan, O.S. (t.y.).Comparing Mathematical Problem Solving Ability Of Pupils Who Learn Abacus Mental Arithmetic And Pupils Who Do Not Learn Abacus Mental Arithmetic.

Martin, H. (2007). Mathematical Literacy. *Principal Leadership v,7 n5, p28-31, January 2007.*

Ministry of National Education (MoNE) Sample Pisa Questions, retrieved from *http://pisa.meb.gov.tr/wp-content/uploads/2013/07/PISA-kitab%C4%B1.pdf* .

National Council of Teachers of Mathematics [NCTM]. (2000). Principles and standards for school mathematics. Reston, VA: Author.

OECD (2010), PISA 2009 Results: What Students Know and Can Do: Student Performance in Reading, Mathematics and Science (Volume I), *OECD Publishing* retrieved from *http://www.oecd-ilibrary.org/education/pisa-2009-results-what-students-know-and-can-do_9789264091450-en*.

Pugalee, D. K. (1999). Constructing a model of mathematical literacy. *The Clearing House, 73 (1), 19-22.*

Uysal, E. , Yenilmez, K. (2011). Sekizici Sınıf Öğrencilerinin Matematik Okuryazarlığı Düzeyi [The Mathematical Literacy Level of Eighth Grade Students]. *Eskişehir Osmangazi University, Sosyal Bilimler Dergisi [Social Sciences Journal], 12(2),1-15, December 2011*

Uzun, M.S. , Yanık, C. , Sezen, N. (2012). Öğretmen Adaylarının Matematik Okuryazarlığı Özyeterliklerinin İncelenmesi [The Exploration of Teacher Candidates' Self-Efficacy Beliefs in Mathematical Literacy]. *Hacettepe University, H. U. Joumal of Education, Special Issue 2: 212-221, [2012]*

Yılmaz, E.T. (2006). Uluslar Arası Öğrenci Basarı Değerlendirme Programı (PISA)' nda Türkiye'deki Öğrencilerin Matematik Başarılarını Etkileyen Faktörler [Factors Influencing the Mathematical Acheivements of Students in Turkey within the Program for International Students and Assessment (PISA)]. *An Unpublished Master's Thesis. Hacettepe University, Ankara.*