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A Research about the Effect of the Mathematical Literacy Level of Secondary School Students on Their Mathematical Success*

Research Article

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ABSTRACT

This study was done with the aim of identifying the Mathematical Literacy Level of students from 8 grades of Secondary School and examining the correlation between mathematical literacy and mathematical success. It also explored how much the effect of the mathematical literacy level of secondary school students on their mathematical success is. Within this framework, the study was designed as correlational survey model. In the questionnaire of the study, there were 334 students from 8 grades of secondary school. "Mathematical Literacy Scale" and "Mathematical Success Test" were used for getting research data. As a result of data analysis, it was determined that mathematical literacy level of secondary school students were, in general, midlevel. When considered the sub-dimension of mathematical literacy scale, it was confirmed that the dimensions of the correlation, research and comment were midlevel. While the discovery-proof level was low, the visiualty dimension was high level. In terms of the relation between mathematical literacy and mathematical success, there was a positive high level relation. This situation can be interpreted as mathematical literacy is important for mathematical success of the students. When the predictive level of mathematical literacy for mathematical success was examined, it was seen that mathematical literacy expressed 73% of mathematical success. So it can be concluded that the level of mathematical literacy is an important factor for Mathematical Success, and In line with the results, if students correlate between the situations, produce different data and use these data, they can be successful in maths.

Keywords:
Literacy, mathematical literacy, mathematical literacy scale, mathematical success, secondary school students

* This study was produced from the first author's master thesis.

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Introduction

Today, there is a need for literate individuals who make an effort for producing new information, critical think, analyse, and plan for self-learning, self- improving (Nergis, 2011). In our information and technology age, developed countries aim to have individuals who are all literate and gain the skills to access, use and evaluate the information. Similarly, the need of individuals who have the ability of science and technology, reasoning, mathematical thinking is getting higher, and the structure that will make it possible for students to understand maths and learn it, is the essential point in changes of education (Franke & Kazemi, 2001).

Literacy, is not only about students' habit of reading-writing, but also being aware of logical thinking, numbers and mathematical operations (NRC, 1989). Mathematics has been exploring the nature around the individuals and the relations between the structures of the brain, and it has been developing in this direction (Schoenfeld, 1992). At the same time, learning maths requires gaining mathematical concepts and ability, and also mathematical thinking, strategies of problem solving and being aware of the fact that maths is quiet important in daily life (MEB, 2009). When considered the relation of maths with daily life and the areas of its usage, the concept of mathematical literacy comes into prominence. Within this framework, mathematical literacy is defined in PISA as "the ability of defining and realising the importance of maths, reasoning with a sound basis, being interested in and using maths as a sensitive individual in a way that responding his own needs **(**OECD, 2003).

Mathematical literacy is seen as a critical concept in mathematical applications. Just as students need to have comprehensive vocabulary for reading and understanding activities, Mathematical terms are needed for understanding and learning maths (Timothy & Quickenton, 2003). Therefore, for mathematical applications in daily life, mathematical literacy has become an outstanding feature for the discussions about the aims of maths education (Meaney, 2007).

It is discussed that the mathematical literacy should be above average for understanding mathematical terms and solving the mathematical problems. Within this framework, mathematical literacy is seen as a must for having a success in maths (Gellert, Jablonka & Keitel, 2001). In consideration of PISA results of literacy, there have been some studies examining the mathematical success of the students in terms of demographic features (İş Güzel & Berberoğlu, 2005; Papanastasiou & Ferdig, 2006; Uysal, 2009). Besides, there have been other studies for determining the relation between mathematical literacy levels and various variables (Akkaya & Sezgin Memnun, 2012; Akyüz & Pala, 2010; Gellert, 2004; Uysal & Yenilmez, 2011). The level of mathematical literacy for increasing the maths success of students is considered crucial. At this point, it can be said that determining the relationship between mathematical literacy and mathematical success has gained importance. In this study, the level of mathematical literacy of 8 grade students is determined and relations between mathematical literacy and mathematical success of sub dimensions is examined. Moreover, the effectiveness of mathematical literacy and its sub dimensions on mathematical success is examined.

Method

In this study, correlational survey model was used, as determining the level of mathematical literacy of 8 grade students and examining the relation between mathematical literacy and mathematical success is aimed. Correlational survey model is a kind of model that aims determining the alteration or alteration level between two or more variables (Karasar, 2011).

Population and Sample

The population of the study is 8 grade students of secondary schools in Elazığ, and the sample is determined as 8 grade students of 4 secondary schools. Within this framework, the working group consists of 344 secondary school students at 8 grade.

Data Collection Tools

As data collection tools, "Mathematical Literacy Scale" and "Mathematical Success Test" are used for determining mathematical literacy level of 8 grade students. Mathematical Literacy Scale (MLS) is a 5 point Likert scale, validity and reliability studies of which have been done in order to measure the literacy level of students at sub dimension. This scale consists of 40 articles. It was graded as; always (5), frequently (4,) sometimes (3), occasionally (2) and never (1).

It also consists of 4 sub-dimensions. Pilot study was done with 500 secondary students at 8 grade. The first one of the sub-dimensions that have been determined through the exploratory factor analyses of the data achieved by pilot studies is *Contacting,* consisting of 19 articles and factor loads of them vary between 475 and 699 values. *Research and interpretation* sub-dimension consists of 12 articles and its factor loads vary between 481 and 639 values. *Discovery-proof* dimension consists of 5 articles and its factor loads vary between 535 and 790 values. *Visuality* dimension consists of 4 articles and its factor loads vary between 576 and 715.At the end of confirmatory factor analysis, it was determined that the articles of scale and sub-dimensions were concerted. Reliability co-efficient of the scale is 967 and split-half reliability co-efficient is 944. Mathematical achievement test consists of 23 multiple-choice and 2 open ended questions, and in total 25 problems. The problems obtained in test consist of learning area of numbers, algebra, geometry, data and possibility. Besides, they were prepared for information, practising and deduction cognitive domains. KR-20 reliability coefficient was determined as 899 for test reliability. Moreover, split-half test reliability was found as 916. So it can be said that success test is a reliable measuring tool.

Data Analysis

Data were acquired from 334 students from 8 grades of secondary school and their answers to the mathematical literacy scale and mathematical success test. The data were analysed statistically. Standard deviation value of mathematical literacy scale as a whole and its sub-dimension is calculated by arithmetic average in order to determine the level of mathematical literacy. Besides, the correlation between mathematical literacy and mathematical success is determined by Pearson product-moment correlation. In order to determine the predictive level of mathematical literacy for mathematical success, linear regression was used. Analysis of variance of the data was calculated, and then regression coefficients, standard errors, and t-scores were calculated.

Findings

At this chapter, the findings about determining mathematical literacy level of students from 8 grades of secondary school and correlation between mathematical literacy and mathematical success. Also, the findings about the predictive level of mathematical literacy for mathematical success was shown. In this sense, the findings about mathematical literacy scale as a whole for mathematical literacy level of students from 8 grades of secondary school are as follows:

Table 1. Arithmetic Mean and Standard Deviation Values for the Whole MLS

Item	Number of Students	Arithmetic Mean	Standard Deviation
1	334	3.49	.992
2	334	3.61	1.059
3	334	3.38	1.155
4	334	3.53	1.111
5	334	4.29	.981
6	334	3.66	1.107
7	334	3.63	1.092
8	334	4.02	1.055
9	334	3.71	1.124
10	334	4.22	1.024
11	334	3.87	1.023
12	334	4.06	1.059
13	334	3.44	1.123
14	334	3.68	1.119
15	334	3.58	1.087
16	334	3.80	1.115
17	334	3.82	1.057
18	334	3.65	1.104
19	334	3.77	1.059
20	334	3.69	1.099
21	334	3.17	1.044
22	334	3.84	1.083
23	334	3.81	1.084
24	334	4.01	.980
25	334	3.01	1.012
26	334	3.61	1.120
27	334	2.99	1.120
28	334	3.83	1.107
29	334	3.92	1.084
30	334	3.92	.991
31	334	4.16	1.051
32	334	3.53	1.087
33	334	3.76	1.060
34	334	3.68	1.153
35	334	3.95	1.072
36	334	3.85	1.030
37	334	3.81	1.005
38	334	4.09	1.011
39	334	3.20	1.045
40	334	2.83	1.077
Mean	334	3.696	1.069

The general average of the students 3,696 in table. The scale articles were evaluated out of 5 and it can be said that mathematical literacy level of students were midlevel. The average of scale articles varied between 2.83 and 4.429. Among the articles, 5th article having "I can understand the expressions and symbols given in tables and graphs" expression had the highest average. Besides, it was confirmed that 40th article having "By combining the given information with my own information, I access different information" expression was at the lowest level among others with 2.83 average.

The findings about the sub-dimension of contacting of the scale are as follows:

Table 2. MLS-Arithmetic Mean and Standard Deviation Values Regarding Contacting

Item	Number of Students	Arithmetic Mean	Standard Deviation
15	334	3.58	1.087
11	334	3.87	1.023
9	334	3.71	1.124
3	334	3.38	1.155
36	334	3.85	1.030
4	334	3.53	1.111
14	334	3.68	1.119
18	334	3.65	1.104
35	334	3.95	1.072
17	334	3.82	1.057
32	334	3.53	1.087
20	334	3.69	1.099
13	334	3.44	1.123
23	334	3.81	1.084
2	334	3.61	1.059
7	334	3.63	1.092
6	334	3.66	1.107
1	334	3.49	.992
30	334	3.92	.991
Mean	334	3.67	1.079

According to the table, the total average of articles is 3.67 out of 5 within the context of relating sub-dimension of scale. Accordingly, the level of the students' mathematical literacy towards relating dimension was determined as mid-level. Moreover, the average of articles varied between 3.38 and 3.95 values. When the articles were examined in general, it was seen that students studied for school subjects but had difficulty in using their current knowledge. It was confirmed that 35th article having "I can correlate the new subject I learned in maths with the former subjects" expression was at the highest level among others with 3.95 average. Besides, it was determined that 3rd article having "I can show the mathematical expression in different ways" expression was at the lowest level among others with 3.38 average.

The findings about the sub-dimension of research and interpreting of the scale are as follows:

Table 3. MLS-Arithmetic Mean and Standard Deviation of Research and Interpretation Dimension

Item	Number of Students	Arithmetic Mean	Standard Deviation
28	334	3.83	1.107
19	334	3.77	1.059
33	334	3.76	1.060
31	334	4.16	1.051
38	334	4.09	1.011
24	334	4.01	.980
26	334	3.61	1.120
16	334	3.80	1.115
34	334	3.68	1.153
37	334	3.81	1.005
22	334	3.84	1.083
29	334	3.92	1.084
Mean	334	3.86	1.069

According to the table, the total average of articles is 3.86 out of 5 within the context of research and interpreting sub-dimension of scale. Accordingly, the level of the students' mathematical literacy towards research and interpreting dimension was determined as mid-level. Moreover, the average of articles varied between 3.61 and 4.16 values. When the articles were examined in general, it was seen that the students studied their lessons, searched from different sources but they didn't make an effort to find new solution ways that they used their current knowledge. It was confirmed that 31st article having "when I don't understand a subject in maths, I try to learn from different sources" expression was at the highest level among others with 4.16 average. Besides, it was confirmed that 26th article having "I try to find new solution ways when solving problem" expression was at the lowest level among others with 3.61 average.

The findings about the sub-dimension of discovery-proof of the scale are as follows:

Table 4. Arithmetic Mean and Standard Deviation Values Related to Invention and Proof Dimension

Item	Number of Students	Arithmetic Mean	Standard Deviation
40	334	2.83	1.077
27	334	2.99	1.120
25	334	3.01	1.012
39	334	3.20	1.045
21	334	3.17	1.044
Mean	334	3.04	1.059

According to the table, the total average of articles is 3.04 out of 5 within the context of discovery-proof sub-dimension of scale. Accordingly, the level of the students' mathematical literacy towards discovery-proof dimension was determined as under mid-level and at a lower level than the other dimensions. Moreover, the average of articles varied between 2.83 and 3.20 values. When the articles were examined in general, it was seen that the students could explain the mathematical operation, prepare a report, but they had difficulty in producing different knowledge. It was confirmed that 39th article having "I can prepare a brief report about my comments and instructions" expression was at the highest level among others with 3.20 average. Besides, it was confirmed that 40th article having "I reach different knowledge by associating my own knowledge with the knowledge given" expression was at the lowest level among others with 2.83 average.

The findings about the sub-dimension of visuality of the scale are as follows:

Table 5. Arithmetic Mean and Standard Deviation Values of Visuality Dimension

Item	Number of Students	Arithmetic Mean	Standard Deviation
5	334	4.29	.981
10	334	4.22	1.024
12	334	4.06	1.059
8	334	4.02	1.055
Mean	334	4.148	1.029

According to the table, the total average of articles is 4.148 out of 5 within the context of Visuality sub-dimension of scale. Accordingly, the level of the students' mathematical literacy towards visuality dimension was determined as above mid-level and at a higher level than the other dimensions. Moreover, the average of articles varied between 4.02 and 4.29 values. When the articles were examined in general, it was seen that the students could understand the expressions at tables and graphics, but they had difficulty in knowledge given at geometry. It was confirmed that 5th article having "I can understand the expressions and the symbol given at table and graphics" expression was at the highest level among others with 4.29 average. Besides, it was confirmed that 8th article having "I know the meanings of the symbols used in geometrical figures" expression was at the lowest level amoung others with 4.02 average.

As a result of the analyses aimed at determining the relation between mathematical literacy and mathematical success, the findings are as follows:

Table 6. The relationship between mathematics achievement and MLS and its sub-dimensions

	Correlation Value	p
Math Success with Mathematical Literacy	.848	.000
Math Success with Contacting	.825	.000
Math Success with Research and Interpretation	.790	.000
Math Success with Discovery-Proof	.743	.000
Math Success with Visuality	.647	.000

According to the table, there is a positive high level relation between mathematical literacy and mathematical success (r=.848, p<.01). When the relation between mathematical literacy and mathematical success was examined, there was a positive high level relation between relating dimension and mathematical success (r=.825, p<.01), a positive high level relation between research and interpreting dimension and mathematical success (r=.790, p<.01), a positive high level relation between discovery-proof dimension and mathematical success (r=.743, p<.01) and a positive midlevel relation between visiualty dimension (r=.647, p<.01). These findings show that there is a positive high level relation between mathematical literacy and mathematical success in general. As a result of the regression analysis about the effectiveness of the mathematical literacy on mathematical success, correlation coefficient between mathematical literacy and mathematical success was determined as R=.851. This showed that mathematical literacy expressed 73% of mathematical success.

Additionally, analysis of variance table about the effectiveness of the mathematical literacy on mathematical success is as follows:

Table 7. Variance Table for Predicting Mathematical Success of Mathematical Literacy

Variance Source	**Sum of Squares**	**sd**	**Mean of Squares**	**F**	**p**
Regression	54878.325	4	13719.581		
Error	20837.795	329	63.337	216.613	.000
Total	7576.120	333			

According to the table, the model that was made in order to evaluate the effectiveness of the mathematical literacy on mathematical success of students from 8 grades of Secondary School, is meaningful at the level of .01 (F(4, 329)=216.613; p=.000).

Regression table about the effectiveness of the mathematical literacy on mathematical success of students, is as follows:

Table 8. Regression Table for Predicting Mathematical Success of Mathematical Literacy

Variables	**B**	**Standard Error**	**Beta**	**t**	**p**
Constant	-14.849	2.603	-	-5.705	.000
Contacting	.468	.074	.431	6.299	.000
Research and Interpretation	.313	.111	.180	2.828	.005
Discovery-Proof	.867	.170	.236	5.097	.000
Visuality	.385	.204	.080	1.886	.060

In the table, according to the standardized regression coefficient (beta), order of importance of the predictor variables on mathematical success was determined as: relating, discovery-proof, research and

interpreting, and visuality. When the result of t-test about regression coefficient was examined, it was confirmed that relating, discovery-proof, research and interpreting sub-dimensions were significant, meaningful predictors for mathematical success ($p<.01$). By the way, the visiuality predictor didn't have so meaningful effect on it.

Discussion, Conclusion and Suggestions

This study was done with the aim of identifying the mathematical literacy level of students from 8 grades of Secondary School, the correlation between mathematical literacy and mathematical success, and determining the effectiveness of the mathematical literacy on mathematical success. Accordingly, the mathematical literacy scale and mathematical success test were applied.

At the end of the study, arithmetic average values of the mathematical literacy scale articles were determined as 3.696 out of 5. This showed that the mathematical literacy level of the secondary school students was midlevel. Similarly, in their studies, Uysal and Yenilmez (2011) determined that the mathematical literacy level of students from 8 grades of Secondary School was under 3, according to PISA evaluation system.

When the sub-dimensions of the scale was examined, it was confirmed that all the students, similarly, were midlevel at relating dimension. As for research and interpreting dimension, the students were at midlevel but they were at a better point when compared to relating dimension. It was determined that among the other sub dimensions, students were at the lowest level in discovery-proof dimension. It was assumed that this was because they wanted students to use the knowledge and produce different knowledge. The highest dimension level of students were visuality. So it can be said that the students get information better visually and so get more interested in lessons. Similarly, in their studies, Uysal Koğ and Başer (2012) concluded that teaching maths with the help of visualization had a positive effect on the attitudes of students towards maths.

It was confirmed that, in terms of the relation between mathematical literacy and mathematical success, there was a positive high level relation ($r=.848$, $p<.01$). This situation can be interpreted as mathematical literacy is important for mathematical success of the students. In parallel with this situation, in his study, Pugalee (1999) emphasized that it is a must to have mathematical literacy in order to be successful at maths. Besides, in their studies, Akyüz and Pala (2010), concluded that there was a high level meaningful relation between problem solving and mathematical literacy. Additionally, various studies were done in order to determine the factors that affect the mathematical literacy level of the students (Akyüz & Satıcı, 2013; Soytürk, 2011; Uysal, 2009). All these studies showed that mathematical literacy was a significant factor in increasing the mathematical success of students. Therefore, it was confirmed that doing studies about mathematical literacy would be efficient in increasing the mathematical success of students.

As a result of the regression analysis about the effectiveness of the mathematical literacy on mathematical success, correlation coefficient between mathematical literacy and mathematical success was determined as $R=.851$. Accordingly, this showed that mathematical literacy expressed 73% of mathematical success and mathematical literacy was an important factor in increasing mathematical success. As a result of variance analysis, done in order to determine the significance of regression equation, it was confirmed that the model that was made in order to evaluate the effectiveness of the mathematical literacy on mathematical success of students from 8 grades of Secondary School, was meaningful at the level of .01. Additionally, it was concluded that, according to the standardized regression coefficient (beta), order of importance of the predictor variables on mathematical success was as: relating, discovery-proof, research and interpreting, and visuality.

As a result of analyses about regression coefficient was examined, it was confirmed that relating, discovery-proof, research and interpreting sub-dimensions were significant, meaningful predictors for mathematical success. By the way, the visiuality predictor didn't have so meaningful effect on it. In a

correlation analysis, it was witnessed that visiuality dimension had a lower relation with mathematical success, compared to other dimensions. Therefore, this analysis also supports the situation. In line with these results, it can be concluded that if the students, at first, correlate between the situations, produce different data and use these data, they can be successful in maths.

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