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Investigation of middle school students' visual math literacy self-efficacy perceptions

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Abstract

In this study, it is aimed to investigate middle school students' visual math literacy self-efficacy perceptions in terms of different variables (gender, grade levels, math achievement, etc.). For this purpose, screening model was employed in the study. The study was carried out 460 middle school students. Demographic information form and "Visual Math Literacy Self-Efficacy Perception Scale" were used as data collection tools. The middle school students' visual math literacy self-efficacy perceptions were found to be at moderate level. There were no significant differences between the students' visual math literacy self-efficacy perceptions according to gender and grade levels. On the other hand, there were significant differences between their visual math literacy self-efficacy perceptions according to math achievement and parents' educational levels. It was observed that the visual math literacy self-efficacy perceptions increased as mathematical achievement increased. It was determined that there was a significant moderate positive correlation between visual math literacy self-efficacy perceptions and math achievement. Besides, visual math literacy self-efficacy perceptions increased as parents' educational levels increased.

Keywords: Visual math literacy; self-efficacy perception; middle school students.

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1. Introduction

Being the primary requirement for learning and teaching both in terms of individuals and the society in the information age that we live in, literacy is described as the ability to perceive, define, analyze, interpret and construct different kinds of resources. There are several types of literacy such as computer literacy, artistic literacy, media literacy, visual literacy and mathematical literacy etc. (Altun 2003; Tuzel, 2010). Fast developments in information and technology have demonstrated the importance of mathematical literacy (NCTM, 1989). Mathematical literacy is described as mathematical knowledge used functionally in several different situations and conditions (Pugalee, 1999). To Lutzer (2005), it means to be able to understand written ideas in the language of mathematics and to communicate. McCrone and Dossey (2007) indicate that mathematical literacy involves processes such as ratiocination and critical thinking as well as to know mathematical concepts and solve routine problems. Mathematically literate individuals use mathematical information in real-life situations and can take rational decisions (Hope, 2007).

It is also necessary to be visually literate to understand both the visual material used in education such as maps, schemas and to understand visual elements such as traffic signs, photographs, computer software etc. (Gunay, 2008). Described as a skill that is necessary in daily life to make an idea clearer; to make sure that the brain remembers more easily and the mental processes are realized in a short time, visual literacy is among the objectives in several education systems around the world. It is also known that visual materials make a great contribution for improving and teaching mathematics (Bekdemir & Duran, 2012). Thus, there is a strong relationship between mathematical literacy and visual literacy (Ipek, 2003). This strong relationship was first recognized by Debes (1968) and a new concept of 'visual mathematics literacy' was introduced. Bekdemir and Duran (2012) described visual mathematics literacy as the visual evaluation of daily problems and mathematical evaluation of the other information. To Tekin and Tekin (2004), visually and mathematically literate individuals can use all their senses and recognize and analyze experiences relevant to shapes, space, time and movement and the representatives of these concepts.

On the other hand, another concept relevant to mathematical literacy and visual literacy that closely affects the motivation, success and behavior of individuals is self-efficacy (Pajares, 2001). Self-efficacy is defined as an individual's judgment relevant to his capacity to successfully complete required activities in order to achieve a certain success (Bandura, 1986). Individuals with a high self-efficacy perception make an effort to perform a task; do not easily give up when they encounter challenges but keep on struggling with patience. However, individuals with a low self-efficacy perception might miss opportunities as they avoid making an effort (Askar & Umay, 2001; Senemoglu, 2009). Considering that self-efficacy should be measured paying attention to the changes in its multidimensional structure and performance content (Zimmerman, 2000), it is thought that it is worth to investigate the visual mathematics self-efficacy perceptions of students. In this regard, it is aimed to investigate the visual mathematics literacy level of middle school students in terms of different variables (gender, grade, math achievement etc.). The results that will be obtained from the study are significant in terms of filling the gap in the relevant field; they will also strengthen the validity and reliability of the existing studies in the literature.

2. Method

2.1. Research method and study group

A screening model is employed in the present study. Screening studies aim to describe the opinion of large masses. The aim is to make a description by taking a picture of the existing situation about the topic of the study (Buyukozturk, Kilic-Cakmak, Akgun, Karadeniz & Demirel, 2012). In this study, it is aimed to find out the visual mathematics literacy self-efficacy perceptions of middle school students.

The study was carried out at a public middle school in Golcuk district of Kocaeli province. 460 middle school students participated in the study. The study group consists of 225 female (48.91%) and 235 male

(51.09%). 146 of the students (31.74%) study at 5th grade; 125 students (27.17%) study at 6th grade; 80 students (17.39%) study at 7th grade and 109 students (23.69%) study at 8th grade.

2.2. Data collection and data collection tools

The data required for the study was obtained through the demographic information form that was prepared to collect demographic information about students and through "Visual Mathematics Literacy Self-Efficacy Perception Scale (VMLSEPS)". In the demographic information form, there are questions to find out the gender, grades, math achievement of students and the educational level of their parents. Explanations about the VMLSEPS are provided below. The data collection was carried out on 19-23 December 2016, during one lesson hour (40 min).

2.2.1. Visual math literacy self-efficacy perception scale (VMLSEPS)

In order to measure the visual math literacy self-efficacy perceptions of students, the visual math literacy self-efficacy perception scale (VMLSEPS) developed by Bekdemir and Duran (2012) was used. The scale consists of 38 items and 3 factors. These factors are; field content, process and situations. The lowest score that can be obtained from the scale is 38 while the highest is 190. A high score points to a high visual math literacy self-efficacy perception. The score range between 190-148 represents the good or the good group; 147-84 represents the medium or the medium group; 83-38 represents the bad and the bad group. The Cronbach's alpha reliability coefficient for the whole scale is 0.943. The reliability coefficients relevant to the factors are 0.653; 0.927 and 0.839 respectively.

In the present study, the Cronbach's alpha reliability for the whole scale was calculated in the first place and found to be 0.931. As for the reliability coefficients for the sub-factors, they were 0.443; 0.919 and 0.820 respectively. Within this scope, the reliability coefficients obtained in the present study were sufficient and in parallel to the findings obtained in previous studies. Besides, the confirmatory factor analysis of the scale was carried out. The fit indexes obtained (X^2/sd=2.34; RMSEA= 0.054; NFI= 0.95; NNFI= 0.97; CFI= 0.97; GFI= 0.85; AGFI= 0.83) demonstrated that the scale was fit for purpose (Kline, 2005; Steiger, 2007; Sumer, 2000; Thompson, 2004).

2.3. Data analysis

First of all, 475 data collection tools obtained within the scope of the study were individually examined by researchers. As a result, it was determined that one student did not fill in the demographic information form and it was decided to exclude this data collection tool from the study. It was also found out that some students filled in the scale by marking only one alternative and answered the scale items by skipping one. Thus, it was decided to eliminate the tools that were answered in this way from the study. In this regard, 9 data collection tools from the 5th grade; 4 from the 6th grade and 1 from the 8th grade were eliminated from the study. As a result, 15 data collection tools were not evaluated within the scope of the study. The analyses were carried out based on 460 data collection tools.

After the obtained data was transferred to computer environment, it was examined whether they had a normal distribution in order to determine whether the analyses would be carried out using parametric techniques or non-parametric techniques. In this regard, Kolmogorov-Smirnov (K-S) test was administered because the data set's being higher than 50 (N=460) required a K-S (Buyukozturk, 2012) test in normality analyses. As a result of the analyses carried out, it was determined that the data did not have a normal distribution and it was determined to use non-parametric tests. So, Mann-Whitney U test was administered in the analyses carried out according to gender and Kruskall-Wallis test was administered in the analyses carried out according to other variables. As the data did not have a normal distribution (Buyukozturk, 2012), it was examined through Spearman correlation whether there is a relationship between mathematical achievement and visual math literacy self-efficacy perception. In the confirmatory factor analysis of the scale, LISREL 8.7 program was used. In other analyses, SPSS 17.0 program was used and the significance level was 0.05.

3. Results

In this part, the students' visual math self-efficacy perception levels and findings obtained from analyses carried out according to different variables were presented in the first place. In order to find out the answer of the question "*What is middle school students' visual math literacy self-efficacy perception level?*" descriptive analyses were carried out and the findings were presented in Table 1.

Table 1. Visual math literacy self-efficacy perception levels

VMLSEPL	N	Mean	sd	Min.	Max.
5	146	147.87	1,90	84	185
6	125	144.96	2,06	70	186
7	80	142.59	2,74	61	181
8	109	143.95	2,50	60	188
Total	460	145.23	1,12	60	188

When Table 1 is examined, it can be seen that the students' visual math literacy self-efficacy perception means were of a moderate level at 145.23. In order to find an answer to the question "*Is there a significant difference in middle school students' visual math literacy self-efficacy perceptions according to gender?*" Mann-Whitney U test was administered. The findings are as follows:

Table 2. Visual math literacy self-efficacy perception & gender

Gender	N	Mean Rank	Sum of Ranks	U	p
Female	225	242.22	54500.5	23799.5	.064
Male	235	219.27	51529.5		

When Table 2 is examined, it is seen that there is not a significant difference in the visual math literacy self-efficacy perceptions of male and female students (U=23799.5; p>0.05). When the mean ranks are taken into account, it can be said that female students had a higher visual math literacy self-efficacy perception than male students. In order to find an answer to *"Is there a significant difference in middle school students' visual math literacy self-efficacy perceptions according to their grades?"* Kruskall-Wallis test was administered. The findings are presented in Table 3.

Table 3. Visual math literacy self-efficacy perception & grades

Grades	N	Mean Rank	sd	X^2	p
5	146	245.00			
6	125	224.88	3	2.965	.397
7	80	215.84			
8	109	228.28			

When Table 3 is examined, it is seen that there is not a significant difference in students' visual math literacy self-efficacy perceptions according to their grades ($X^2 = 2.965$; p= .397> .05). When the mean ranks are taken into account, it is found out that 5th grade students have the highest visual math literacy self-efficacy perception. In order to answer the question "*Is there a significant difference in the middle school students' visual math literacy self-efficacy perceptions according to their mathematics achievement?*" Kruskall-Wallis test was administered. The findings are presented on Table 4.

Table 4. Visual math literacy self-efficacy perception & math achievement

Math achievement scores	N	Mean Rank	sd	X^2	p	Significant Differences
1	104	132.25	4	117.573	.000	1-2, 3, 4, 5 2-4, 5 3- 4, 5 4-5
2	50	189.23				
3	78	205.42				
4	81	272.99				
5	147	303.94				

According to Table 4, it is seen that there is a significant difference in students' visual math literacy self-efficacy perceptions according to their math achievement ($X^2 = 117.573$; p= .000< .05). When the mean ranks are examined, it is seen that the students who got 5 had the highest visual math literacy self-efficacy perception. It was also determined that there was a significant difference in the perception of the students whose math score was 5 in comparison to the others. Additionally, it was investigated whether there was a significant relationship between students' visual math literacy self-efficacy perceptions and mathematics achievement. Accordingly, it was found out that there was a significant moderate positive relationship between students' visual math literacy self-efficacy perceptions and mathematics achievement (r= .520; p< .000). In order to answer the question *"Is there a significant difference in middle school students' visual math literacy self-efficacy perceptions according to their parents' educational levels"* Kruskall-Wallis test was administered. The findings are presented in Table 5 and Table 6.

Table 5. Visual math literacy self-efficacy perception & mothers' educational level

Educational level	N	Mean Rank	sd	X^2	p
İlliterate	11	193.77	5	12.553	.028
Primary School	96	211.59			
Middle school	124	213.76			
High School	163	239.26			
University	58	275.22			
Post-Graduate	8	264.63			

When Table 5 is examined, it is seen that there is a significant difference in students' visual math literacy self-efficacy perceptions according to their mothers' educational levels ($X^2 = 12.553$; p= .028< .05). It was determined that the mothers of the students whose visual math literacy self-efficacy perception was the highest were university graduates. It was also seen that the students' visual math literacy self-efficacy perception scores increased as their mothers' education level increased. The following results were obtained from the analyses carried out according to fathers' educational level:

Table 6. Visual math literacy self-efficacy perception & fathers' educational level

Educational level	N	Mean Rank	sd	X^2	p
İlliterate	2	137.75	5	36.058	.000
Primary School	53	172.54			
Middle school	99	200.77			
High School	218	233.52			
University	80	295.40			
Post-Graduate	8	274.31			

In Table 6, it is seen that there is a significant difference ($X^2 = 36.058$; p= .000< .05) in students' visual math literacy self-efficacy perceptions according to their fathers' educational levels. It was also determined that the fathers of the students whose visual math literacy self-efficacy perception was the highest were university graduates. It was also seen that the students' visual math literacy self-efficacy perception scores increased as their fathers' education level increased.

4. Conclusions, Implications and Recommendations

In the present study where middle school students' visual math literacy self-efficacy perceptions are investigated, it was determined that their visual math literacy self-efficacy perceptions were at a moderate level. This result is parallel to the result obtained from the study carried out by Birgin and Gulbez (2014). However, Ozdemir, Duran and Kaplan (2016) concluded in their study that students' visual math literacy self-efficacy perceptions were above the moderate level. In this regard, it can be said that middle school students' visual math literacy self-efficacy perceptions are at a moderate and high level. It is suggested that teachers enrich their lessons with activities that improve students' perceptions which might increase the achievement levels both in geometry and mathematics lessons. It is also thought that students' visual math literacy self-efficacy perceptions can be increased by concretizing the subjects as much as possible.

When the visual math literacy self-efficacy perceptions of students were analyzed according to the gender variable, it was seen that there was not a significant difference in male and female students' perceptions. This result is in parallel to the results of similar studies in the literature (Birgun & Gulbez, 2014; Duran, 2011). Besides, it can be said that female students' visual math literacy self-efficacy perceptions are higher. This result is in parallel to the results of the studies demonstrating a difference in visual math literacy self-efficacy perceptions of students in favor of female students (Ozdemir, Duran & Kaplan, 2016; Sengul, Katrancı & Gulbagci, 2012; Tutkun, Erdogan & Ozturk, 2014). However, there are also studies concluding that the visual math literacy self-efficacy perceptions differed significantly in favor of male students (Ozgen & Bindak, 2011; Sari-Uzun, Yanik & Sezen, 2012). When looked from this perspective, it is not possible to make a clear statement about how meaningful the difference in the visual math literacy self-efficacy perceptions of students is according to the gender variable. For this reason, it is thought that it can be useful to investigate this point in future studies. It may also result from cultural differences. It is considered that students' interaction with the environment they live in is important.

Another result obtained in the study is not the difference in middle school students' visual math literacy self-efficacy perceptions according to grades. This result is in parallel to the results of other studies in the literature (Birgun & Gulbez, 2014; Tutkun, Erdogan & Ozturk, 2014). It was determined in the study that 5th grade students had the highest perception score which is very striking. The increase seen in students' perception scores as the grade goes up is also worth attention. This situation might result from the fact that the math subjects become more difficult as the grade goes up.

As a result of the present study, it was also found out that the visual math literacy self-efficacy perceptions of students differed significantly according to mathematics achievement. As the self-efficacy perception in any subject is closely related to achievement (Pajares, 2001; Senemoglu, 2009), this result which is also in parallel to the results of other studies (Birgun & Gulbez, 2014; Ozgen & Bindak, 2011; Sengul, Katranci & Gulbagci, 2012; Tutkun, Erdogan & Ozturk, 2014). In the literature is very significant. In this regard, the visual math literacy self-efficacy perceptions of middle school students can be increased if some measures are taken to increase math achievement. It was also found within the scope of the study that there was a significant, moderate positive relationship between maths achievement and visual math literacy self-efficacy perception.

There is a significant difference in the visual math literacy self-efficacy perceptions of middle school students according to their parents' educational levels. It was concluded in the present study that the perception scores of students whose parents are university graduates are higher in comparison to others. The study carried out by Tutkun, Erdogan and Ozturk (2014) points to a significant difference in the visual math self-efficacy perceptions of students according to fathers' education levels but concludes that there is no significant difference according to mothers' education levels. While the studies are not in parallel to each other according to mother's education levels; they are parallel in terms of the variable of fathers' education level.

Besides the results obtained, the visual math literacy self-efficacy perception can be considered as a new concept. For this reason, it is thought that this subject should be studied more. It is also recommended to seek an answer to the questions "What variables affect this concept? and "What measures can be taken to increase this perception?".

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