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THE CHANGE OF VISUAL MATHEMATICS LITERACY PERCEPTION LEVELS OF PRE-SERVICE ELEMENTARY SCHOOL TEACHERS OF MATHEMATICS BY GENDER AND GRADE LEVEL

(Araştırma Makalesi)

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Abstract

In the current study, it is aimed to investigate the visual mathematics literacy (VML) levels of pre-service elementary school teachers of mathematics depending on gender and grade level within the scope of general and sub-dimensions. It is possible to see that the types of questions such as visuality and reading comprehension have been preferred more in exams in recent years. As a result of the concepts of visuality and reading comprehension, VML is a new concept that emerged for the field of mathematics. The concept of VML is a concept that needs to be well understood by students, teachers and pre-service teachers. Therefore, in this study, it has been tried to reveal the level of the VML phenomenon that emerges within the framework of visuality and reading comprehension in all stages of pre-service teachers' education, whether there is a difference in terms of gender related to these concepts, and what the situation of pre-service teachers is in the context of grade level, and the research is important in this context. The survey model was used in the study, and 113 pre-service elementary school teachers of mathematics participated in the study. The Visual Mathematics Literacy Perception Scale (VMLPS) was used as a data collection tool. Within the scope of the current study, it was found that the Geometric Knowledge category of VMLPS has a higher average, the values of the Pattern Creation and Concretization categories are close to each other, VML perception levels of women and men are similar, and when the mean of the sub-dimensions are considered, it is determined that there is a small difference in favor of men for all dimensions. A significant

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difference is determined between the dimensions of Spatial Intelligence, Pattern Creation and total score arithmetic averages according to the grade variable.

Keywords: *Literacy, Mathematics Literacy, Pre-service Teachers of Mathematics, Visuality, Visual Mathematics Literacy.*

İlkogretim Matematik Öğretmen Adaylarının Görsel Matematik Okuryazarlığı Algı Düzeylerinin Cinsiyete ve Sınıf Düzeyine Göre Değişimi

Öz

Mevcut araştırmada ilköğretim matematik öğretmen adaylarının görsel matematik okuryazarlığı (GMOY) düzeylerinin genel ve alt boyutlar kapsamında cinsiyete ve sınıf düzeyine bağlı olarak araştırılması amaçlanmıştır. Görsellik ve okuduğunu anlama gibi soru türlerinin son yıllarda sınavlarda daha çok tercih edildiğini görmek mümkündür. Görsellik ve okuduğunu anlama kavramları sonucunda GMOY matematik alanı için ortaya çıkan yeni bir kavramdır. GMOY kavramı öğrenci, öğretmen ve öğretmen adayları için çok iyi anlaşılması gerekli olan bir kavramdır. Bundan dolayı bu çalışmada öğretmen adaylarının eğitimlerinin bütün aşamalarında görsellik ve okuduğunu anlama çerçevesinde ortaya çıkan GMOY olgusunun ne sevide olduğu, cinsiyet bakımından bu kavramlar özelinde bir farklılık olup olmadığı, sınıf seviyesi bağlamında öğretmen adaylarının durumunun nasıl olduğu ortaya konulmaya çalışılmış olmakta olup, araştırma bu bağlamda önem taşımaktadır. Araştırmada tarama modeli kullanılmış olup, 113 ilköğretim matematik öğretmen adayı katılmıştır. Veri toplama aracı olarak Görsel Matematik Okuryazarlığı Algı Ölçeği (GMOAÖ) kullanılmıştır. Mevcut araştırma kapsamında GMOAÖ'nün Geometrik Bilgi kategorisinin daha fazla ortalamaya sahip olduğu, Örüntü Oluşturma ve Somutlaştırma kategorilerinin değerlerinin birbirine yakın çıktığı, kadınların ve erkeklerin GMOY algı düzeylerinin benzer olduğu, alt boyutların ortalamaları dikkate alındığında ise, tüm boyutlara göre erkekler lehine küçük bir farkın olduğu belirlenmiştir. Uzamsal Zekâ, Örüntü Oluşturma boyutlarında ve toplam puan aritmetik ortalamaları arasında sınıf değişkenine göre anlamlı farklılık belirlenmiştir

Anahtar Kelimeler: Görsellik, Görsel Matematik Okuryazarlığı, Matematik Okuryazarlığı, Matematik Öğretmen Adayları, Okuryazarlık.

1. INTRODUCTION

In these days, through education, it is aimed for individuals to acquire skills such as creative and critical thinking, being productive, and producing solutions to the problems they encounter. In other words, people are expected to use the knowledge and skills, they have learned, in their daily lives, and to be able to produce information from knowledge, thus becoming beneficial individuals for the society. In this age, it is essential to produce knowledge and to reach a modern education system by using the produced knowledge. Since mathematics skill is the most important tool that improves the thinking, discussion

and reasoning skills of individuals, it plays an important role in the production of knowledge and the acquisition of appropriate skills (Aygüner, 2016).

In determining the future visions of societies, various goals such as "being an information society, doing science and producing technology" come to the fore. In order to achieve these goals and new goals, it is necessary to develop various skills, especially lifelong learning and science literacy, and to acquire many literacy skills. Indeed, the concept of "literacy" is very important in establishing the goals and objectives of structuring programs in the education systems of many countries. Nowadays, in order for individuals to become a member of the information society, it has become a necessity to be literate in other fields besides information literacy. Literacy of mathematics, which is a universal language, is one of these literacy (Aygüner, 2016).

In Cambridge Advanced Learner's Dictionary, mathematics literacy is defined as being able to read and write and to have knowledge on a specific subject or a specific type of knowledge. Therefore, mathematics literacy is seen as knowledge and skills about finance, social, economy, culture and modern civilization that must be acquired throughout life (Lailiyah, 2017). There are many ways to analyze and structure the connection between school and out-of-school mathematics. Mathematics literacy concepts are based on this relationship because these are related to the ability of the individual to use mathematics that he learns in school (Jablonka, 2003).

The ability to use mathematics knowledge and solve problems is closely related to mathematical literacy skills. In other words, students with good mathematical literacy will be able to solve various daily problems (Kurniawati and Mahmudi, 2019). A mathematically literate adult should know examples of tecnological applications related to mathematics, be able to decode popular texts involving mathematics, and participate in political debates using statistics and results from mathematical models. The ability to understand and evaluate different applications involving mathematics is an important component of mathematical literacy (Jablonka, 2003).

Increasing scientific developments in the 21st century and the technological products that emerge as a result of these developments greatly affect human life. This development changes the human characteristics and social values needed by the age. While literacy was based on literacy and mathematics in the previous periods, today it has expanded further and started to be based on visual knowledge (Tanrıverdi and Apak, 2013).

Visual literacy is a comprehensive skill that enables the development of certain skills found in individuals and serves the purpose of learning and teaching (Aygüner, 2016). Visual literacy means the ability of interpreting and creating visual elements of texts, and 'ordinary' literacy is the ability of reading, writing and understanding words in texts. These visual elements or visuals texts, such as drawing and photographs; it includes tables, diagrams, graphs, maps, timelines, and flowcharts (Griffiths, 2001). With the importance of visuality since ancient times, the consept of visual literacy has been formed over time, and VML has been formed with the increase in the importance of visuality together with mathematical literacy (İlhan, Çelik and Poçan, 2016).

Visual literacy is important due to the presence of visuals, drawings, charts and graphics, numbers and symbols in mathematics (Aygüner, 2016) and visual mathematics literacy emerges as a new concept for the ability to read, interpret, evaluate, use and create new visual conditions (Çilingir and Artut, 2016). VML is defined as "the ability to perceive, express, interpret, evaluate and use the problems encountered in daily life visually or spatially and visual or spatial information mathematically" (Bekdemir and Duran, 2012). VML is also expressed as the process of using mental activities while creating the images encountered, getting help from paper-pencil or technology, and using these images for mathematical exploration or understanding (Çilingir, Altıner and Artut, 2017).

VML and visualization concepts are new to the education system in our country. With the transition to constructivist education in 2005, visuals and concretion concepts came to the fore. Visuals were added to the course and workbooks with the works carried out by the Ministry of National Education, and the importance of the visuals in the teaching environment was emphasized. In addition, the importance of VML was emphasized in the International Student Assessment Project carried out by the Economic Cooperation and Development Organization (İlhan, Çelik and Poçan, 2016).

In the education system, it is important for the teachers to be visual mathematics literate as well as the students. More permanent and meaningful learning can be provided for individuals who have a sufficient amount of VML. The high VML levels of pre-service teachers and teachers enable them to prepare richer and educational visuals, use images more consciously, and establish the relationship between mathematics education and daily life (İlhan, Çelik, and Poçan, 2016). Students whose teachers lack visual information in their classroom practices are deprived of one of the most important ways of developing conceptual knowledge. This can demoralize the students and reduce their interest in the subject (Kundema, 2016). With the development of VML in the world, studies in this field have started in our country and have become important. However, considering the PISA, MEB and OSYM exams, the success in mathematics and geometry and therefore the VML is still low in our country. In recent years, studies in this field have increased in our country and various arrangements have been made in the program. As a result of these studies, the average in the PISA exam has increased slightly. Increasing the studies in this field and the VML level may be important in terms of mathematics achievement, and increasing the VML levels of teachers and students in education can also positively affect the education process. Considering the literature, it is seen that visual perception level affects mathematics and geometry achievement. In addition, important scientists such as Bruner, Duchastel, Arnheim, Curtiss, Branton also supports the concept of visuality (İlhan, Çelik and Poçan, 2016).

With the importance of mathematics in the world of science, mathematics education has also become important (İlhan, 2019). In other words, mathematics education is as important as mathematics (İlhan, Çelik and Poçan, 2016; İlhan, 2019). Mathematics

is included in almost all education programs at all levels of education in our country (İlhan, 2019) and there are various deficiencies in all levels of education, in the field of mathematics education. Mathematics education is a whole with teachers, students, materials, methods and techniques and there are principles that complement this integrity. One of these principles is the concrete-to-abstract principle. Visuality is very important as individuals learn more easily what they perceive as concrete rather than abstract. Today, where development is experienced in every field, new information, opportunities and tools are reshaping the processes of learning and teaching mathematics (İlhan, Çelik and Poçan, 2016; İlhan, 2019).

Children and adolescents' ability to learn mathematics and their awareness of mathematical thoughts can only be developed through verbal, numerical, visual, symbolic and written communication in mathematics. For everyone, perception of mathematics, mathematics literacy, and expressions of progress in mathematics are more than just slogans and have become one of the main goals. In addition, this situation has created a field of education and research that every society should invest in (İlhan, Tutak and Çelik, 2019).

In international exams such as PISA and TIMMS, mathematics questions related to reading comprehension and interpretation of visual expressions are asked. Regarding the visual expressions given in these questions, students are expected to be literate. It is seen that more emphasis has been placed on mathematical questions related to metacognitive reading comprehension in the national exams held in our country in recent years (Aksu, Uzun and Çelik, 2019).

To be successful in mathematics, individuals are required to have psychologically high levels of belief in their potential achievements. One of the important affective factors affecting a person's performance in any field is their self-efficacy perception. Visual mathematics literacy self-efficacy perception has an important place in mathematics education. Therefore, students with high self-efficacy perception of visual mathematics literacy spend a lot of effort and time to understand mathematics subjects, keep their goals high, work in an organized and planned manner, make an effort to overcome the problems they encounter, and are patient in their studies (Çelik, 2019).

As a result of the literature reviews on VML, it is determined that the relationships between visual mathematics literacy and students' actual performance, mathematics self-report levels, problem solving skills, metacognitive awareness of reading comprehension, geometry achievement, and mathematics achievement are examined. In addition, the effects of realistic mathematics education and the use of dynamic geometry programs on VML are also examined. Apart from that, the relationships between VML and gender, grade level, parents' educational status, achievement status, achievement grade and daily life are also examined by associating them with mathematical concepts. Opinions of students and pre-service teachers about visual mathematics literacy are also taken. There have also been researchers who developed various scales on VML.

The literature study shows that there is no significant relationship between VML self-efficacy perceptions and students' performances, the students consider themselves sufficient in terms of general and field content of VML, process and situations in which it is used (Aygüner, 2016), the students' VML self-efficacy perception levels, respectively; female students (Deveci and Aldan Karademir, 2018; Özdemir, Duran and Kaplan, 2016) lower classes, those with high grades, and democratic teachers and democratic parents differed significantly (Deveci and Aldan Karademir, 2018); however, in the study of İlhan and Aslaner (2020), it was found that males had a higher average than females within the scope of VML perceptions and sub-dimensions, and third grade pre service teacher had the highest average and in the studies of Aksu, Uzun and Çelik (2019), Şengül, Kaba and Özdişçi (2017) and Çelik (2019), it was determined that the VML self-efficacy perception levels of students did not differ significantly according to gender.

In the study of Lailiyah (2017), it was determined that male students were good in all indicators of mathematical literacy skills (from the first indicator to the sixth indicator), while female students were good in all indicators except the fifth indicator. These indicators are as follows:

1. Developing a mathematical model on your own
2. Writing down the answers as if you were calculating consistently
3. Create or use model images, tables, graphs, such as to help find answers
4. Choosing and comparing strategies to help find answers
5. Reasoning by relating relevant information to existing experience
6. Using and processing formulas or specific mathematical procedures for answers

In the study of Şengül, Kaba, and Özdişçi (2017), it was seen that there was no significant difference between students' VML self-efficacy perceptions and grade level. It has been determined that various methods used (Realistic Mathematics Education, Use of Dynamic Geometry Software) increase VML perceptions at a high level (Çilingir and Artut, 2016; Çilingir Altıner and Dinç Artut, 2017; İlhan and Aslaner, 2017). In Duran (2013) study, it was aimed to determine the views and thoughts of primary school 7th grade students about VML. It is seen that students understand visual problems better than verbal problems, most of the students use visual mathematics literacy as “a literacy based on being able to read, understand and interpret shaped questions”, “literacy based on mastery of visual shapes and symbols”, “explaining mathematics with the help of visuals” and "geometry literacy" and it has been determined that they express the basic characteristics that a visual mathematical literacy should have, such as "to comprehend visuals, to have visual intelligence, to transform visuals into words and to make use of visuals in daily life".

In the study of Tanrıverdi and Apak (2013), it has been determined that postgraduate theses in the field of visual literacy in Turkey are mostly limited to studies to determine or develop visual perception skills of primary school students, and there are almost no

studies in teacher education in adult education, which is one of the elements of lifelong education, and therefore, the current studies are not at a level to reveal the sufficiency or inadequacy of our country's level of visual literacy. The studies carried out are generally at the primary and secondary education level, and a limited number of studies have been encountered on determining the VML levels of pre- service teacher. It was determined that the VML of the classroom teachers was not at a sufficient level (Çalık Uzun and Çelik, 2017), and a low correlation in various dimensions was determined by examining the relationship between VML and geometry achievements (İlhan, Tutak and Çelik, 2019).

In the study of Kurniawati and Mahmudi (2019), 9th grade students' mathematical literacy skills were found to be moderate, and students' ability to apply concepts, facts and procedures was found to be high. It was determined that most students had difficulties in formulating situations mathematically and making discussions based on the information obtained or mathematical results. It was determined that the students' mathematics self-efficacy was high. Students have a good belief in their ability in mathematics, their success in learning mathematics, and their resilience and perseverance in achieving difficulties in mathematics. A moderate correlation was found between mathematical literacy and mathematical self-efficacy.

Currently in our country, there are student selection exams at many levels that students must pass or be successful while planning their future. The main purpose of these exams is to rank the students according to the correct number of questions they have made and to allow them to be placed in any undergraduate program. When the questions of these exams are analyzed, various implications can be made about why successful or unsuccessful students succeed or fail. One of the most important items of these implications is whether the types of questions asked in the exams are understood correctly by the student because correct interpretation of question types shows that there is a direct effect on students' success in exams. It is possible to see that the types of questions in the form of visuality and reading comprehension have been preferred more in exams in recent years. Therefore, visuality and reading comprehension should be very well understood by both students and teachers in the studies to be conducted. The solution phase of this problem for teachers depends on the education they receive during their undergraduate period because the pedagogical and field education knowledge that gained in the period of being a pre-service teachers contributes to the solution of this problem. As a result of the concepts of visuality and reading comprehension, VML is a new concept that emerged for the field of mathematics. The concept of VML is a concept that should be well understood for students, teachers and pre-service teachers. Therefore, in this study, it has been tried to reveal the level of the VML phenomenon that emerges within the framework of visuality and reading comprehension at all stages of pre-service teachers' education, whether there is a difference in terms of gender in terms of these concepts, and how the situation of pre-service teachers is in the context of grade level and research is important in this context.

Determining the mathematical literacy self-efficacy perceptions by gender is important because of the difference in the success of boys and girls in the selection exams and the differences in the way they think about mathematics. Determining the differences according to the grade level is important in terms of determining whether there is any change in the students' perspectives and approaches to mathematics as the grade level rises.

In the current study, it is aimed to investigate the VML levels of elementary school pre-service teachers of mathematics within the scope of general and sub-dimensions depending on gender and grade level. In this context, the problem of the study is as follows: Do the VML levels of the elementary pre-service teachers of mathematics differ by gender and grade level? Depending on this problem, answers are sought for the following sub-problems.

1. How do VML levels of primary school pre-service teachers of mathematics differ according to general and sub-dimensions?
2. Do VML levels of primary school pre-service teachers of mathematics differ in terms of gender according to general and sub-dimensions?
3. Do VML levels of primary school pre-service teachers of mathematics differ in terms of grade levels according to general and sub-dimensions?

2. METHODOLOGY

2.1. Research Model

In the research, the survey model was used. In the survey model, a past or present situation is described as it is (Karasar, 2005). Within the scope of the present research, the general survey model was used among the survey models. In the general survey model, in order to make a general judgment about the universe, a survey is performed on a sample taken from it (Karasar, 2005). Within the scope of the study, it was aimed to determine the visual mathematics literacy levels of elementary school pre-service teachers of mathematics according to their gender and grade levels.

2.2. Population / Sample

The population of the study consists of the elementary school pre-service teachers of mathematics studying in the education faculties of the universities in the Eastern Anatolia Region, and the sample of the study consists of 113 elementary school pre-service teachers of mathematics who are studying in the Mathematics Education Program of the Department of Mathematics and Science Education of the Kafkas University Dede Korkut Education Faculty. 43 pre-service teachers of mathematics from 1st grade, 23 from 2nd grade, 23 from 3rd grade and 24 from 4th grade participated in the study conducted in the spring term of 2019-2020. Within the scope of the research, convenience

sampling, one of the non-random sampling methods, was used. Within the scope of the research, convenience sampling, one of the non-random sampling methods, was used. In convenience sampling, the sample is selected from easily accessible and practicable units (Gurbetoğlu, 2018).

2.3. Data Collection Tools

The Visual Mathematics Literacy Perception Scale (VMLPS), developed by İlhan (2015), is a 5-dimensional (Visual Perception, Geometric Knowledge, Spatial İntelligence, Concretization and Pattern Formation) and a 5-point likert-type scale, and it consists of 37 items, all of which are positive. Some of the items in the scale are as follows: "I can draw a three-dimensional shape with a front, top and left view", "By breaking up a three-dimensional object, I can get new three-dimensional objects", "From a shaped pattern given steps 3 and 5, I can find the general term", "I can create and solve a modeled decimal number problem", "I can make a geometric proof of the Pythagorean relation", "I can model exponential numbers geometrically". The Cronbach Alpha reliability coefficient of the scale is 0.904, and the lowest score that can be obtained from the scale is 37 and the highest score is 185 (İlhan and Aslaner, 2017).

2.4. Analyzing of Data

Within the scope of the current study, a statistical package program was used for the analysis of the data, the scores obtained by pre-service teachers of mathematics from the scale were tabulated by calculating frequency (f), percentage (%), average ($\bar{X}$) and standard deviation (sd) values. One-way analysis of variance (Anova) was conducted to determine whether the VMLPS scores differ significantly according to the class variable. As a result of the normal distribution of the research findings, it was checked whether the difference between the averages is significant or not in dependent groups with "the t-test". Post-hoc comparison analysis was used in order to determine which groups cause this difference. In order to decide which comparison technique would be preferred, at first, the homogeneity of the variances was checked, and the LSD test was preferred because the variances are found homogeneous.

2.5. Research Ethics

Before starting this research, an application was made to the Social and Human Sciences Research and Publication Ethics Committee of Kafkas University. At the meeting of the Ethics Committee dated 12.07.2021 and numbered 21, it was decided that the research named "The Change Of Visual Mathematics Literacy Perception Levels Of Elementary School Pre-service Teachers of Mathematics By Gender And Grade Level" is ethically appropriate. The citations were made in accordance with scientific rules and the volunteering of the participants was taken as a basis in the research.

3. FINDINGS

Table 1. VMLPS Personal Information

Variable		f	%
Gender	Female	69	61,1
	Male	44	38,9
Class	1st Grade	43	38,1
	2nd Grade	23	20,4
	3rd Grade	23	20,4
	4th Grade	24	21,1
TOTAL		113	100

When Table 1 is examined, it is seen that 113 people participated in the study in total. 61.1% of them are female and 38.9% are male. 43 (38.1%) people from the 1st grade, 23 (20.4%) from the 2nd grade, 23 (20.4%) from the 3rd grade, and 24 (21.1%) from the 4th grade participated in the study.

Table 2. VMLPS Overall Score Averages

VMLPS	N	$\bar{X}$	sd	Total
Visual Perception	113	3,41	,780	385,57
Geometric Information	113	4,19	,620	473,90
Spatial Intelligence	113	3,87	,755	437,60
Concretization	113	4,00	,644	452,00
Pattern Creation	113	4,12	,751	466,67
TOTAL	113	3,92	,588	443,15

VMLPS has been evaluated in 5 subcategories. Considering Table 2, the average, standard deviation, and total score of these five categories are presented. The averages of the categories are obtained as 3.41 for Visual Perception, 4.19 for Geometric Knowledge, 3.87 for Spatial Intelligence, 4.00 for Concretization, 4.12 for Pattern creation, and 3.92 in total. Considering the semantic dimensions of the categories, it is seen that the Geometric Information category has more on an average. When the items of the Geometric

Knowledge category are analyzed in the subcategories of VMLPS, it can be said that more information is referred to. In other words, the pre-service teacher states that when faced with a situation within the framework of knowledge, s/he can apply the existing knowledge on the given problems. In the averages of the subcategories of VMLPS, the value of both Pattern Creation and Concretization is close to each other. Once again, when the item frames of these categories are examined, it can be said that pre-service teachers seem capable of revealing the existence of information.

Table 3. Independent Groups t-Test by Gender

VMLPS	Gender	N	$\bar{X}$	sd	t	p
Visual Perception	Female	69	3,363	,789	-,831	0,408
	Male	44	3,488	,768		
Geometric Information	Female	69	4,171	,637	-,487	0,627
	Male	44	4,229	,598		
Spatial Intelligence	Female	69	3,817	,761	-,972	0,333
	Male	44	3,959	,746		
Concretization	Female	69	3,965	,620	-,717	0,475
	Male	44	4,054	,683		
Pattern Creation	Female	69	4,082	,790	-,844	0,401
	Male	44	4,204	,686		
TOTAL	Female	69	3,879	,594	-,946	0,346
	Male	44	3,987	,578		

As can be seen in Table 3, as a result of the independent t-Test conducted to determine whether the gender variable differentiates the perception level of visual mathematics literacy, the difference between the VMLPS, Visual Perception, Geometric Knowledge, Spatial Intelligence, Concretization, Pattern Creation and total scores of the groups is not found to be statistically significant (t = -, 831, -, 487, -, 972, -, 717, -, 844, -, 946; p> 0.05).

Considering the results of the Independent Groups t-Test for VMLPS, it is seen that there is no significant difference in the sub-factors of VMLPS. Considering the averages of the sub-factors, it seems that there is a small difference in favor of men on the basis of all factors.

Table 4. One-Way Analysis of Variance (Anova) Results Conducted to Determine Whether VMLPS Scores Show a Significant Difference According to the Class Variable

Scale	Class	N	Source of Variance	Sum of Squares	Sd	Average of Squares	F	p
Visual Perception	1st Grade	43	Intergroup	2,15	3	,717	1,182	,320
	2nd Grade	23	Within Groups	66,095	109	,606		
	3rd Grade	23						
	4th Grade	24						
	Total	43	Total	68,245	112			
Geometric Knowledge	1st Grade	23	Intergroup	2,936	3	,979	2,651	,052
	2nd Grade	23	Within Groups	40,230	109	,369		
	3rd Grade	24						
	4th Grade	43						
	Total	23	Total	43,166	112			
Spatial Intelligence	1st Grade	23	Intergroup	6,801	3	2,267	4,326	,006*
	2nd Grade	24	Within Groups	57,124	109	,524		
	3rd Grade	43						
	4th Grade	23						
	Total	23	Total	63,925	112			
Concretization	1st Grade	24	Intergroup	1,066	3	,355	,853	,468
	2nd Grade	43	Within Groups	45,414	109	,417		
	3rd Grade	23						
	4th Grade	23						
	Total	24	Total	46,480	112			
Pattern Creation	1st Grade	43	Intergroup	8,468	3	2,823	5,620	,001*
	2nd Grade	23	Within Groups	54,740	109	,502		
	3rd Grade	23						
	4th Grade	24						
	Total	43	Total	63,207	112			
Total	1st Grade	43	Intergroup	3,423	3	1,141	3,521	,018*
	2nd Grade	23	Within Groups	35,331	109	,324		
	3rd Grade	23						
	4th Grade	24						
	Total	43	Total	38,754	112			

As seen in Table 4, as a result of one-way analysis of variance (Anova), which was conducted to determine whether the VMLPS scores show a significant difference

according to the class variable, the difference between the Spatial Intelligence, Pattern Creation dimensions and the total score arithmetic averages of the groups are found to be statistically significant (F = 4,326, 5,620, 3,521; p <.001). Post-hoc comparison analysis was used in order to determine which groups cause this difference. In order to decide which comparison technique would be preferred, firstly, the homogeneity of the variances was checked and LSD test was preferred because the variances were found homogeneous. The results obtained are presented below.

Table 4.1. Post-Hoc LSD Test Results After One-Way Analysis of Variance (ANOVA) Conducted to Determine Between Which Groups VMLPS Spatial Intelligence Scores Differ by Class Variable

Spatial Intelligence	Class	Class	Difference Between Averages	p
Spatial Intelligence	1st Grade	2nd Grade	-,52457*	,006*
		3rd Grade	-,13327	,478
		4th Grade	-,54341*	,004*
	2nd Grade	1st Grade	,52457*	,006*
		3rd Grade	,39130	,070
		4th Grade	-,01884	,929
	3rd Grade	1st Grade	,13327	,478
		2nd Grade	-,39130	,070
		4th Grade	-,41014	,055
	4th Grade	1st Grade	,54341*	,004*
		2nd Grade	,01884	,929
		3rd Grade	,41014	,055

As seen in Table 4.1, as a result of the LSD test after one-way analysis of variance (Anova), which was carried out to determine among which groups the VMLPS spatial intelligence dimension scores differ according to the class variable, it was determined that the difference in question occurred at the level of p <.05 in favor of the 2nd grade between the 2nd grade and the 1st grade groups, and at the level of p <.05 in favor of the 4th grade between the 4th grade and the 1st grade groups. The difference between the arithmetic means of the other groups was not found to be significant (p> .05). The basic thing in mathematics is that the student reveals his own mathematical phenomenon by performing the concretization stage. In other words, if the student has reached the level of performing mathematical abstraction, it means that he has reached a certain level in terms of performing mathematical operations. Learning three-dimensional objects at an important stage of students' education life poses a problem for them due to the inadequacy of the teachers and the inability of the students in mathematical abstraction at

the stage of interpreting three-dimensional objects, especially in primary education and secondary education. As seen in Table 4.1, the 4th grade and 1st grade are compared, it is seen that the 4th grade is more advanced and in the comparison of the 2nd grade and the 1st grade, it is seen that the 2nd grade is more advanced in the spatial intelligence dimension in the mathematical phenomenon. In essence, it can be inferred that pre-service teachers have acquired abstract thinking skills and are more successful in the implication phase by means of the theoretical mathematics lessons that they take as their grade level rises. Considering the spatial intelligence items in VMLPS, it was aimed to test the qualification of pre-service teachers especially in conducting operations with three dimensional objects. Making sense of three dimensional objects requires a certain process. In other words, if the pre-service teachers could not internalize the abstract phase of mathematics strongly, it would be troublesome for them to interpret three-dimensional objects. In the comparison in Table 4.1, the fact that the upper classes have reached an advanced level of awareness in the spatial intelligence dimension is important in terms of showing that the mathematics education that the pre-service teachers receive contributes to the mathematical maturity of the pre-service teachers. The fact that the spatial dimension tests how pre-service teachers handle three-dimensional objects is also important for them to plan their professional lives because every achievement specific to mathematics education that pre-service teachers acquired in their learning process contribute to their ability to present them correctly to students and to encourage students to internalize mathematics and reinforce their attachment of mathematics.

Table 4.2. Post-Hoc LSD Test Results After One-Way Analysis of Variance (Anova) Conducted to Determine Between Which Groups VMLPS Pattern Creation Scores Differ According to the Class Variable

Pattern Creation	Class	Class	Difference Between Averages	p
Pattern Creation	1st Grade	2nd Grade	-,68453*	,000*
		3rd Grade	-,22076	,230
		4th Grade	-,51001*	,006*
	2nd Grade	1st Grade	,68453*	,000*
		3rd Grade	,46377*	,029*
		4th Grade	,17452	,401
	3rd Grade	1st Grade	,22076	,230
		2nd Grade	-,46377*	,029*
		4th Grade	-,28925	,165
	4th Grade	1st Grade	,51001*	,006*
		2nd Grade	-,17452	,401
		3rd Grade	,28925	,165

As seen in Table 4.2, as a result of the LSD test after one-way analysis of variance (Anova), which was carried out in order to determine among which groups the VMLPS pattern creation dimension scores differ according to the class variable, it was determined that the difference in question is realized at the level of $p < .05$ in favor of the 2nd Grade between the 2nd Grade and the 1st Grade, in favor of the 2nd Grade between the 2nd Grade and the 3rd Grade, and in favor of the 4th Grade between the 4th Grade and the 1st Grade. The difference between the arithmetic means of the other groups is not found significant ($p > .05$). It can be said that the main goal of creating patterns is to generalize in mathematics, that is, to achieve the outcome of writing the mathematical result statement. The meaning of generalization is that the student can derive all results related to that topic in a mathematical context or in the framework of algebraic mathematical operations by inferring terms expressed on a topic basis. Pattern creation items of VMLPS are as follows; 'I can draw step 5 of a shaped pattern given Step 2 and Step 3', 'I can find the general term from a shaped pattern given steps 3 and 5', 'I can create and solve a modeled decimal fraction problem'. Considering Table 4.2, it can be stated that, in general, the upper classes have stronger mathematical phenomena in the Pattern Creation dimension. However, in the comparison of the 2nd and 3rd grade, it is interestingly seen that the 2nd grade is better than the 3rd grade. It can be stated that this is a problem that must be examined by researchers who would do similar research because the general acceptance is that as the grade level increases, the mathematics knowledge level of the pre-service teachers will increase and this will contribute to more positive results in dimensions such as pattern creation or etc.

Table 4.3. Post-Hoc LSD Test Results After One-Way Analysis of Variance (Anova) to Determine Which Groups the VMLPS Total Scores Differ According to the Class Variable

Visual Mathematics Literacy Perception Scale	Class	Class	Difference Between Averages	p
VMLPS (TOTAL)	1st Grade	2nd Grade	-,39369*	,009*
		3rd Grade	-,14180	,337
		4th Grade	-,37968*	,010*
	2nd Grade	1st Grade	,39369*	,009*
		3rd Grade	,25188	,136
		4th Grade	,01401	,933
	3rd Grade	1st Grade	,14180	,337
		2nd Grade	-,25188	,136
		4th Grade	-,23788	,155
	4th Grade	1st Grade	,37968*	,010*
		2nd Grade	-,01401	,933
		3rd Grade	,23788	,009

As seen in Table 4.3, as a result of the LSD test after one-way analysis of variance (Anova), which was conducted to determine among which groups the VMLPS total scores differ according to the class variable, it was determined that the difference in question is realized at the level of p <.05 in favor of the 2nd grade between the 2nd grade and 1st grade groups, and in favor of the 4th grade between the 4th grade and the 1st grade groups. The difference between the arithmetic means of the other groups is not found significant (p> .05). Considering the general total results of VMLPS, it is seen that a positive difference has emerged in favor of the upper classes. As the most obvious reason for this, it can be argued that as the learning stages of pre-service teachers evolve higher in terms of level, the intellectual structures specific to mathematics also improve positively. Once more, the development of the abstract perspectives of the pre-service teachers in the mathematics lessons they take positively confirms the result of the research in favor of the upper classes. Pre-service teachers go through a new process in the undergraduate education phase in order to gain professional skills of mathematics teaching during the undergraduate education phase. The perspective of pre-service teachers on mathematics when they started their undergraduate education and their way of looking at mathematics when they reach their graduation period are not the same. It is clearly expressed by the education experts who teach this course. As stated by the education experts, it is observed that the pre-service teachers at the graduation stage have improved in terms of mathematical thinking and mathematical perspective considering the papers given in

the course exams and the results obtained in the professional exams at the last stage of their undergraduate education. It can be said that another reason for graduate teacher candidates to show positive results on the visual mathematics literacy perception scale is the applied vocational courses that pre-service teachers took during their undergraduate period. Pre-service teachers who are just starting the first grade, deal with mathematics by comparing the acquisitions related to mathematics that they obtained in secondary education. This point of view shows the limitations of 1st grade pre-service mathematics teachers' intellectual forms of mathematics. However, 4th and 2nd grade pre-service teachers of mathematics view mathematics with a more comprehensive thought pattern by means of the theoretical courses such as analysis, abstract mathematics, elementary number theory, analytical geometry, geometry, etc., as well as mathematics education classes such as mathematics special teaching methods, misconceptions, mathematics with games, mathematics activities, etc. The understanding stated above reflects positively on the result of the research.

4. CONCLUSION, DISCUSSION AND SUGGESTIONS

Within the scope of the current research, it is seen that the Geometric Knowledge category of VMLPS has a higher average. The values of the Pattern Creation and Concretization categories are close to each other. It was determined that the visual mathematics literacy perception levels of women and men are similar, and considering the averages of the sub-dimensions, there is a small difference in favor of men according to all dimensions. A significant difference is determined between the dimensions of VMLPS Spatial Intelligence, Pattern Creation and the arithmetic mean of the total score according to the class variable. It is determined that VMLPS spatial intelligence dimension scores differ between the 2nd grade and 1st grade groups in favor of the 2nd grade, and between the 4th grade and 1st grade groups in favor of the 4th grade. The difference between the arithmetic means of the other groups is not found to be significant. It is determined that VMLPS pattern creation dimension scores differ in favor of the 2nd Grade between 2nd Grade and 1st Grade, in favor of the 2nd Grade between 2nd Grade and 3rd Grade, in favor of the 4th Grade between 4th Grade and 1st Grade. The difference between the arithmetic means of the other groups is not found to be significant. Considering the time of the study, the reason why the 2nd grade is better compared to the 3rd grade can be said to be that the achievements of the 2nd grade students in primary and secondary education are better than the 3rd grade students or that the 3rd grade students do not learn the concepts of the Pattern Creation dimension at the primary and secondary education stage. It is determined that VMLPS total scores differ between the 2nd grade and 1st grade groups in favor of the 2nd grade, and between the 4th and 1st grade groups in favor of the 4th grade. The difference between the arithmetic means of the other groups is not found to be significant.

Tanrıverdi and Apak (2013) stated that there are almost no studies on determining visual perception skills for adult education in Turkey. Studies are generally at secondary

and high school level (Bekdemir and Duran, 2012; Çilingir and Artut, 2016; Aygüner, 2016; Çelik, 2019; Kurniawati and Mahmudi, 2019). In addition to the determination of the relevant competencies of the students at this level is important in terms of early diagnosis and taking the necessary precautions, it is noteworthy that there are limited studies on pre-service teacher. In such studies, the studies on pre-service classroom teachers(Çalık Uzun and Çelik, 2017) and the relationships between VML and geometry achievements in pre-service teachers (İlhan, Tutak and Çelik, 2019) were examined. In this context, within the scope of the current study, the VML levels of pre-service elementary school teacher of mathematics were tried to be determined by considering them in terms of grade and gender.

Within the scope of the study, it is determined that the visual mathematics literacy perception levels of women and men are similar, and when the averages of the sub-dimensions are considered, there is a small difference in favor of men according to all dimensions. In this context, the current study contradicts with the studies of Deveci and Karademir (2018), Özdemir, Duran and Kaplan (2016), since a significant difference is found in favor of girls; however, it can be said that there is a partial similarity with the study of Ilhan and Aslaner (2020) and Lailiyah (2017), since a significant difference is determined in favor of males in the sub-dimensions. However, considering that the visual mathematics literacy perception levels of women and men are similar in general, it is parallel to the study of Şengül, Kaba, and Özdişçi (2017), Aksu, Uzun and Çelik (2019). Considering the total scores of visual mathematics literacy, it is determined that there is a significant difference between the class level variable. However, the study of Şengül, Kaba, and Özdişçi (2017) contradicts the relevant study, since it is determined that there is no significant difference between self-efficacy perceptions of visual mathematics literacy and class level. In the study of Deveci and Karademir (2018), a meaningful difference occurs in favor of the lower classes. When considered within the scope of certain sub-dimensions, a significant difference is found in favor of upper classes within the scope of the present study. In this respect, the current research contradicts with the related study. Within the scope of the present study, a significant difference is found between the 2nd grade and 1st grade groups in favor of the 2nd grade, and between the 4th grade and 1st grade groups in favor of the 4th grade, while the difference between the arithmetic mean of the other groups is not found significant. Considering the general total results of VMLPS, it is seen that there is a positive difference in favor of the upper classes. Although there is no significant difference between the 3rd grade and the other grade levels, it is generally in favor of the upper classes. In this context, it is in parallel with the study of İlhan and Aslaner (2020). In Lailiyah's study (2017), it is determined that male students are good in all indicators of mathematical literacy skills (from the first to the sixth indicator), while female students are good in all indicators except the fifth indicator. Considering the indicators presented by Lailiyah, it can be said that there is a parallelism in terms of visuality, which is claimed to contribute to the development of geometry, in terms of creating models, reading graphs, creating new correlations and being able

to make operations with these relations, and in terms of the positive view of preservice teachers in all sub-dimensions of VMLPS. The best indicator of this is that the averages of all dimensions are close to each other in the study.

Considering the semantic dimensions of the categories of VMLPS, it is seen that the Geometric Knowledge category has a higher average on average. The Geometric Knowledge category, which is among the categories of the scale, points to geometry literacy, since it is one of the features that must be found in visual mathematics literacy, and in Duran's study(2013), it was determined that the teacher candidates are generally good within the scope of this feature, which the students stated as one of the features that should be found in visual mathematics literacy because the geometric knowledge category average is higher than the average of all other categories. In addition, in Duran's study(2013), students associated visual mathematical literacy with visual knowledge in addition to geometric knowledge. Based on the results obtained in the current research, it can be said that pre-service teachers within the scope of the present research also have the basic features that visual mathematics literacy should have, such as " to be able to comprehend visuals, to have visual intelligence, to convert visuals to verbal and verbal to visuals, and to benefit from visuals in daily life". However, it was determined that the average of the visual perception category scores was lower than the averages of all other categories. Various methods with proven effectiveness can be used to improve pre-service teachers' VML perceptions. It has been determined that especially the methods such as Realistic Mathematics Education and the use of Dynamic Geometry Software increase the VML perceptions at a high level (Çilingir and Artut, 2016; Çilingir Altıner and Dinç Artut, 2017; İlhan and Aslaner, 2017).

Considering the sub-dimensions of VMLPS within the framework of geometry, the aim is the development of spatial intelligence, reinforcement of concretization, development of geometric information, comprehension of pattern formation, and development of visual perception. Learning these dimensions at a high level by teachers and pre-service teachers will be of great benefit in minimizing the problems encountered in geometry lessons. As one of the most important factors of not understanding the geometry lessons, it is shown that the given figures cannot be interpreted by the student, the meaning of the shape is not noticed and the operational analysis cannot be made on the figure. When all dimensions of VMLPS are examined, it can be said that it will contribute to the elimination of the above-mentioned deficiencies. Therefore, it will be beneficial to include these dimensions as headings in the geometry curriculum to be learned by pre-service teachers. In fact, the presentation of all analyzed geometry dimensions in primary and secondary education programs by adding them to the learning outcome dimensions is considered positive for the early development of geometry. Students' perceptions that geometry questions are solved only with “formulas" are mentioned extensively. With the study, it can be shown step by step that all dimensions in VMLPS can be handled on a question-based basis and that this question-based approach can be applied in all education levels.

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EK-1 Etik Kurul Kararı

Karar 16 :KAFKAS ÜNİVERSİTESİ REKTÖRLÜĞÜ Dede Korkut Eğitim Fakültesi Dekanlığı'nın E-22093 sayı ve 02.07.2021 tarihli yazısı kurulumuzca incelenmiş olup, Matematik ve Fen Bilimleri Eğitimi Bölümü Matematik Eğitimi Anabilim Dalı Öğretim Üyelerinden Doç. Dr. Esra ALTINTAŞ'ın Doç. Dr. Şükrü İLGÜN ile yürütmeyi planladığı "The Change Of Visual Mathematics Perception Levels Of Elemantary School Pre-Service Teachers Of Matehematics By Gender And Grade Level" başlıklı çalışmalarının **kabulüne**,

Karar 17: KAFKAS ÜNİVERSİTESİ REKTÖRLÜĞÜ Dede Korkut Eğitim Fakültesi Dekanlığı'nın E-22093 sayı ve 02.07.2021 tarihli yazısı kurulumuzca incelenmiş olup, Matematik ve Fen Bilimleri Eğitimi Bölümü Matematik Eğitimi Anabilim Dalı Öğretim Üyelerinden Doç. Dr. Esra ALTINTAŞ'ın Doç. Dr. Şükrü İLGÜN ve Yüksek Lisans Öğrencisi