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EDITOR: ASSOC. PROF. DR. TAYFUN TUTAK

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PRE-SERVICE SCIENCE TEACHERS' PERCEPTIONS AND ATTITUDES TOWARDS ORGANIC FOOD PRODUCTS

Mehmet Polat[1]

ABSTRACT

Today, the concepts of sustainable agriculture and food safety are becoming increasingly important. In this context, organic food products are of great importance in terms of environmentally friendly production and healthy nutrition. In this study, it was aimed to determine the perceptions and attitudes of pre-service science teachers towards organic food products. The research was conducted with descriptive survey model. The study group consisted of 106 pre-service science teachers studying in the 1st, 2nd, 3rd and 4th grades of the Department of Science Teaching, Faculty of Education, Fırat University in the 2023-2024 academic year. "Personal Information Form" and "Organic Food and Good Agricultural Products Perception and Attitude Questionnaire" were used as data collection tools. The survey data were analyzed with SPSS package program. According to the results of the research, it was determined that there were some negativities in the perceptions of pre-service science teachers towards organic food products. Pre-service teachers think that these products are difficult to access, their prices are quite high and promotional activities are insufficient. They also stated that consumers have difficulty in distinguishing these products from other food products and therefore, it is necessary to carry out promotional and awareness-raising activities for organic food products in media tools, especially social media.

Keywords: Pre-service Science Teachers, Organic Food, Good Agricultural Practices, Perception, Attitude.

INTRODUCTION

Nutrition is considered one of the cornerstones of human life and is one of the fundamental human rights necessary for maintaining a healthy life. Today,

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complex factors such as globalization, economic prosperity, free trade, food production and distribution conditions, cultural factors, developments in food industry and technology, urbanization, climate change and nutrition transition significantly affect the nutrition and health status of individuals and societies. This leads to fundamental changes in diet and eating habits (TBSA, 2019). Diet and food systems play a critical role in shaping public health outcomes. Balanced diets, including both macro- and micronutrients and other health benefits, are achieved through food systems. These systems encompass the production, processing, packaging, transportation and marketing of food consumed worldwide (Haddad et al., 2016).

Global changes and developments have a significant impact on the nutrition and health status of societies. Factors such as rapid population growth, socio-cultural factors, technological developments, developments in the food industry, urbanization and socio-economic inequalities lead to changes in dietary habits and health indicators (Republic of Turkey Ministry of Health 2015). One of the most prominent consequences of these changes is the differentiation of eating habits and increased consumption of unhealthy food. This leads to an increase in the incidence of non-communicable diseases such as obesity, diabetes, cardiovascular diseases and hypertension (Özdenk Demir 2021; Yılmaz 2020). With the advancement of technology and increased industrialization, production opportunities have also expanded. While this has led to changes in eating habits and adversely affected public health, it has also increased the pressure on the environment. This increasing environmental pressure has led businesses to implement “green policies” that will cause less damage to the environment in marketing strategies, product features, pricing, promotion and distribution activities. The environmentally sensitive approaches of producers and the increasing ecological problems around the world have contributed to the awareness of consumers on these issues and to the change in consumption behaviors. This change has led to an increased interest in organic food, which is a healthier and more sustainable production.

The negative consequences of the intensive agricultural practices brought about by the Green Revolution led to the need to maintain agriculture in a natural balance and to obtain quality products. Born out of this search, organic agriculture is a concrete result of the search for access to healthy and reliable food (Kızılaslan and Olgun, 2012). Shaped in the early 19th century, the concept of organic food is of increasing importance for both businesses and consumers today. This has led to a significant growth in the demand for organic foods and in the organic food market. A critical issue for organic food marketers is to understand the environmental factors that influence consumers’ decision-making processes. Factors such as natural environment, social and cultural environment, technological environment, economic, legal and political environment and demographic environment directly affect consumers' attitudes towards organic food and their purchase intentions (Çabuk and Nakıboğlu, 2003).

In recent years, with the widespread understanding of healthy and conscious nutrition, the demand for organic foods has also increased. This leads to the widespread use of the term "organic" in marketing and misleading statements on the labels of some products. As Sezerel (2018) points out, the lack of information on access to organic food leads consumers to be selective in their perception of terms such as natural, natural, hormone-free, 100% pure, genuine and village product when choosing products. Such terms are used as a marketing strategy and do not always mean that the product is organic.

The increasing demand and supply observed in the organic food market appears as a mutually feeding cycle. In this cycle, an increase in supply triggers demand, while increased demand leads to an expansion of supply. For this cycle to function in a healthy way, it is critical to raise awareness of both producers and consumers (Ayla and Altıntaş, 2017). According to research, conscious and informed consumers believe that organic food has a positive impact on their health in the long term. This belief leads them to new consumption preferences and increases the demand for organic food (Hasançebi, 2010). Nutrition, which was a basic need in the past, has become an action that can be learned and developed today. Conscious consumer choices have played a leading role in this change (Bloch-Dano, 2015).

The foundations of community and environmental development are laid in primary science courses. These lessons contribute to raising conscious and responsible individuals of the future by providing children with the opportunity to investigate and examine the natural and scientific world in which they live. Observation and investigation is a fundamental process in science teaching. Teachers' focus on this process and active involvement of students in this process ensures that concepts are better understood and become permanent. The aim of science courses is not only to provide students with basic knowledge, but also to enable them to adopt and apply this knowledge in a way that they can use it in their daily lives.

In this context, education should be provided with a student-centered method based on experimental studies, observation and investigation by moving away from the rote learning approach. Teachers should follow an approach that makes students active in the process of acquiring scientific knowledge by making connections with daily life, giving concrete examples and making them active (Polat & Önal Karakoyun, 2022). In this way, students begin to see science not only as a theoretical field but also as a tool that affects their daily lives and contributes to their development.

Science subjects are a difficult subject for most students to learn because they include abstract and complex concepts. In order to better understand why students have difficulty in science classes, there are many scientific studies conducted on students' reasoning (Karakoyun & Asiltürk, 2020a; Karakoyun & Asiltürk, 2020b; Karakoyun & Asiltürk, 2021; Karakoyun & Asiltürk, 2022), science textbooks and other factors (Bağır, at all. 2022; Çelik, et al. 2022) that affect science learning. The aim is to teach students solid and permanent science by using the data obtained as a result of these studies. One of the subjects that are desired to be taught in science classes is food and nutrition. Adopting healthy lifestyle behaviors is critical to protecting and improving the health of all individuals. Science teachers, as one of the main elements of education and training activities, have the responsibility to set an example for families, students, parents and society. In this context, food literacy and awareness of sustainable agricultural practices constitute an important part of the equipment of science teachers. This study aims to examine pre-service science teachers' perceptions and attitudes towards organic food products. By using quantitative and qualitative data collection techniques, the research aims to analyze pre-service science teachers' knowledge, attitudes and behaviors on this issue in depth.

Purpose of the Study

This study was designed to include undergraduate students studying in the 1st, 2nd, 3rd and 4th grades at Fırat University, Faculty of Education, Department of Science Teaching. The aim of the study is to examine the perceptions and attitudes of these prospective teachers towards organic food products.

Research Model

In this study, descriptive survey model, one of the survey models, was used. Descriptive surveys are studies conducted on large groups of participants, aiming to determine the opinions and attitudes of individuals in these groups about a particular phenomenon or event and to describe the phenomenon or event in question (Karakaya, 2012). This method is used to describe the structure of objects, societies and institutions and the functioning of events (Cohen, Manion, & Morrison, 2007). In the current study, descriptive survey method was preferred in order to examine the perceptions and attitudes of pre-service teachers towards organic food products.

Working Group

The study group of this research consists of a total of 106 pre-service teachers studying in the 1st, 2nd, 3rd and 4th grades in the Department of Science Teaching at the Faculty of Education, Fırat University in the 2023-

2024 academic year. Simple random sampling method was preferred as the sampling method. In simple random sampling, the probability of selection of each unit is equal. In this method, it is first necessary to have a comprehensive list of all units. Then, random units are selected from this list. Simple random sampling can be easily applied when the population is not very large and complex. The most important advantage of this method is that statistical procedures can be performed unweighted. In this way, sampling error and evaluation procedures can be easily calculated (Kılıç, 2013).

Data Collection Tools

In this study, the "Perception and Attitude Questionnaire on Organic Food and Good Agricultural Products" developed by Nasırlı (2019) was used as a data collection tool. The questionnaire aims to determine pre-service teachers' knowledge, perceptions and attitudes towards organic food products with 33 five-point Likert-type questions. In the study, an additional personal information form consisting of four questions was also applied to determine the gender, grade level, place of residence and monthly income of the family.

Data Collection

In this study, the data collection process consisted of two stages. In the first stage of the research, two digital forms, namely a personal information form and a Perception and Attitude Questionnaire on Organic Food and Good Agricultural Products, were prepared to collect data related to the research. The following steps were followed in the data collection phase:

- Introducing the Research: The researcher entered predetermined classes and informed the participants about the subject and purpose of the research. At this stage, it was clearly stated that participation was voluntary, the data collected would be kept confidential and would only be used for this research.

- Providing Access to the Forms: After the necessary explanations, the participants were provided with the links to both forms via WhatsApp groups created by the class representatives.

- Answering the Questionnaires: Participants filled out the questionnaires by clicking on the links sent to them. Participants were given 20 minutes to complete the questionnaires.

Data Analysis

In this study, the data collected through digital forms were analyzed using SPSS statistical package program. The aim of the study is to measure pre-service science teachers' perceptions and attitudes towards organic food products. In this context, descriptive statistical methods were utilized. The analysis of the data obtained was carried out using basic statistical indicators such as mean and percentage. In this way, it was aimed to determine some socio-economic characteristics of the consumers participating in the survey. Within the scope of descriptive analysis, arithmetic mean and standard deviation, one of the measures of central tendency, were used. Arithmetic mean is a frequently preferred method in statistics and is known for its sensitivity to changes in data. In the descriptive analysis section, which constitutes the first stage of the analysis, demographic variables such as gender, age, education level and income level of the participants as well as statements to measure their knowledge and awareness levels about organic agricultural products were included.

RESULTS

Information on Personal Characteristics of Prospective Science Teachers

Information about the personal characteristics of pre-service science teachers is given in Table 1.

Table 1. Findings related to the personal characteristics of pre-service science teachers

Gender	Groups	Frequency	Percentage
Gender	Male	42	39,6
	Female	64	60,4
	Total	106	100,0
Grade	1st grade	21	19,8
	2st grade	28	26,4
	3st grade	33	31,1
	4st grade	24	22,7
	TOTAL	106	100,0
Montly income level	1-10 thousand TL	3	2,8
	10-20 thousand TL	42	39,6
	20-30 thousand TL	26	24,5
	30-40 thousand TL	23	21,7
	Over 40 thousand TL	12	11,4
	TOTAL	106	100,0

When Table 1 is analyzed, it is seen that 60.4% of the pre-service teachers participating in the study are female and 39.6% are female; 31.1% of them are 3rd grade, 26.4% are 2nd grade, 22.7% are 4th grade and 19.8% are 1st grade; 39.6% of them have a salary of TL 10,000-20,000, 24.5% have a salary of TL 20,001-30,000, 21.7% have a salary of TL 30,001-40,000. It is seen that 39,6% of them have a monthly income between 10.000-20.000 TL, 24,5% between 20.001-30.000 TL, 21,7% between 30.001-40.000 TL, 11,4% between 40 thousand TL and above and 2,8% between 1-10.000 TL.

Prospective Science Teachers' Views on Consumption of Food Products

In this part of the study, pre-service science teachers' opinions on who is the family member who decides on food purchases, where food products are purchased from, and the negative effects of pesticide, hormone and chemical residues in vegetables-fruits and market products on health were asked. The opinions of pre-service science teachers on the subject are given in Table 2.

Table 2. Distribution of pre-service science teachers' opinions on the question "Who is the family member who decides on food shopping in your home?"

The person who decides on food shopping	Frequency	Percentage
Father	31	29,2
Mother	75	70,8
TOTAL	106	100,0

When Table 2 is examined, it is seen that 70.8% of the pre-service teachers stated that their mothers decide on food shopping at home, while 29.2% stated that their fathers decide. The opinions of pre-service teachers about where they buy food products are given in Table 3.

Table 3. Distribution of pre-service teachers' opinions on the question "where do you usually buy food products?"

Where they procure food products	Frequency	Percentage
Bazaar	68	64,2
Greengrocer	14	13,2
Supermarket	20	18,9
Vilage	6	5,7
Other	9	8,5

*Participants were able to select more than one option

When Table 3 is examined, it is seen that 64.2% of the pre-service teachers stated that they buy food products from neighborhood markets, 18.9% from supermarkets, 13.2% from greengrocers, 8.5% from other places such as internet, neighbor's garden, their own gardens and 5.7% from villages. The distribution of pre-service teachers' views on the effect of chemical residue levels such as pesticides and hormones in fresh vegetables and fruits on their health is given in Table 4.

Table 4. Prospective teachers' opinions on the item "I think that pesticides, hormones and chemicals in fresh vegetables, fruits and packaged market products I consume affect my health negatively"

Pesticides, hormones and chemicals in vegetables, fruits and packaged market products negatively affect my health	Frequency	Percentage
Strongly disagree	2	1,9
Disagree	5	4,7
Undecided	7	6,6
Agree	19	17,9
Strongly agree	67	63,2
TOTAL	106	100,0
Arithmetic Mean	4,19	
Standard Deviation	0,65	

When Table 4 is examined, it is seen that 63.2% of the pre-service teachers "strongly agree", 17.9% "agree", 6.6% "undecided", 4.7% "disagree" and 1.9% "strongly disagree" with the opinion item "I think that pesticides, hormones and chemicals in fresh vegetables, fruits and packaged market products I consume affect my health negatively"; It is seen that pre-service teachers generally responded to this opinion item at the level of "agree" ($\bar{X}$ = 4,19), although they were close to "strongly agree".

Knowledge, Perceptions and Attitudes of Prospective Science Teachers towards Organic Food Products

In this part of the study, findings related to pre-service science teachers' knowledge, perceptions and attitudes towards organic food products are presented. The findings related to the pre-service science teachers' having heard the concepts of "organic or ecological agriculture" before are given in Table 5.

Table 5. Pre-service science teachers' answers to the question "Have you heard the concepts of organic or ecological agriculture before?"

Have you heard of organic or ecological agriculture before?	Frequency	Percentage
Yes	98	92,4
No	3	3,8
No answer	3	3,8
Total	103	100,0

When Table 5 is examined, it is seen that 92.4% of the pre-service science teachers stated that they had heard the concepts of organic or ecological agriculture before, 3.8% stated that they had not heard these concepts before, and 3.8% left this question unanswered. The findings regarding the pre-service science teachers' knowledge of the concepts of "organic or ecological agriculture" are given in Table 6.

Table 6. Pre-service science teachers' answers to the question "Do you know what the concepts of organic or ecological agriculture are?"

Do you know what organic or ecological agriculture is?	Frequency	Percentage
Yes	72	67,9
No	16	15,1
No answer	18	17,0
TOTAL	106	100,0

When Table 6 is examined, it is seen that 67.9% of the pre-service teachers stated that they knew what organic or ecological agriculture was, 15.1% stated that they did not know what these concepts were, and 17.0% left this question unanswered. The distribution of pre-service science teachers' answers to the question "Are products sold without packaging or labeled as 'natural and additive-free' organic food?" is given in Table 7.

Table 7. Preservice science teachers' answers to the question "Are products sold without packaging or labeled as 'natural or additive-free' organic food?"

Are products sold without packaging or labeled 'natural or additive-free' organic food?	Frequency	Percentage
Yes	26	24,5
No	69	65,1
No idea	9	10,4
TOTAL	106	100,0

When Table 7 is examined, it is seen that 65.1% of the pre-service science teachers stated that the products sold without packaging or labeled as 'natural or additive-free' are not organic food, 24.5% of them stated that they are organic food and 10.4% of them stated that they have no idea about the subject. The distribution of pre-service science teachers' answers to the question "Do you know that fresh vegetables and fruits sold without packaging should be sold with an organic product certificate" is given in Table 8.

Table 8. Preservice science teachers' answers to the question "Do you know that fresh vegetables and fruits sold without packaging should be sold with organic product certificate?"

Do you know that fresh vegetables and fruits sold without packaging should be sold with an organic product certificate	Frequency	Percentage
Yes	47	44,3
No	59	55,7
TOTAL	106	100,0

When Table 8 is analyzed, it is seen that 55.7% of the pre-service science teachers know that fresh vegetables and fruits sold without packaging should be sold with an organic product certificate, while 55.7% of them stated that they did not know this. Findings related to "frequency of organic food consumption" of pre-service science teachers are given in Table 9.

Table 9. Findings on the frequency of pre-service teachers' consumption of organic food

How often do you consume organic food?	Frequency	Percentage
Very rare	33	31,1
Rare	17	16,0
Once in a while	20	18,9
Often	27	25,5
Very often	9	8,5
TOTAL	106	100,0
Arithmetic Mean	2,64	
Standard Deviation	0,77	

When Table 9 is examined, it is seen that 31.1% of the pre-service teachers stated that they consume organic food "very rarely", 25.5% "frequently", 18.9% "occasionally", 16.0% "rarely" and 8.5% "very frequently". It is seen that the pre-service teachers are generally close to "rarely" in this opinion item, but they express their opinions at the level of "once in a while" ($\overline{X}$ = 2.64). The findings related to the reasons why pre-service teachers do not buy organic products are given in Table 10.

Table 10. Findings related to the reasons why pre-service teachers do not buy organic products

What are your reasons for not buying organic products?	Frequency	Percentage
I think the products I consume are healthy	41	38,7
I do not know enough about organic products	19	17,9
I find the prices of organic products too expensive	34	32,1
I have enough income to buy organic products, but I think they are unnecessarily expensive	40	37,7
It is very difficult to find organic products in the market	17	16,0
I do not think organic products are safe	22	20,8

* Participants were able to select more than one option

When Table 10 is examined, it is seen that 38.7% of the pre-service teachers stated that the products they consume are healthy, 37.7% stated that although they have enough income to buy organic products, they are unnecessarily expensive, 32.1% stated that the prices of organic products are too expensive, 20.8% stated that organic products are not safe, 17.9% stated that they do not have enough information about organic products and 16.0% stated that it is very difficult to find organic products in the market and that they do not buy organic products. The opinions of pre-service teachers about how much more they can pay for organic products are given in Table 11.

Table 11. Prospective teachers' opinions on how much more can be paid for organic products

How much more can you pay for organic products than regular products?	Frequency	Percentage
%0-25 more than	62	58,5
% 26-50 more than	27	25,5
%51-75 more than	12	11,3
%76-100 more than	5	4,7
TOTAL	106	100,0

* Participants were able to select more than one option

When Table 11 is examined, it is seen that 58.5% of the pre-service teachers stated that they could overpay for organic products by 0-25%, 25.5% by 26-50%, 11.3% by 51-75% and 4.7% by 76-100%. The opinions of pre-service science teachers about how much they can overpay for organic products are given in Table 11.

Findings Related to the Perceptions and Attitudes of Prospective Science Teachers towards Organic Food Products

Findings related to pre-service science teachers' perceptions and attitudes towards organic food products are given in Table 12.

Table 12. Findings related to pre-service science teachers' perceptions and attitudes towards organic food and good agricultural products

Questions	X	ss
I care about the environmental and health impacts of food products	4,09	0,58
I can easily find organic products	3,11	0,42
I find the variety of organic products sufficient	2,80	0,53
It is important for me that the products I buy are environmentally friendly	4,37	0,61
I think organic product inspections are sufficient	2,43	0,55
I know the control and inspection processes of organic products	2,07	0,44
I read the information on the products I buy	3,95	0,70
Non-organic products are harmful to health	2,44	0,62
There is no difference between natural products and organic products	2,78	0,56
TOTAL	106	100,0

When Table 12 is examined, it is seen that the pre-service teachers strongly agree with the opinion item "it is important for me that the products I buy are environmentally friendly" ($\bar{X}$ = 4,37); agree with the opinion item "I care about the effects of food products on the environment and health" ($\bar{X}$= 4,09); agree with the opinion item "I read the information on the products I buy" ($\bar{X}$ = 3,95); not sure about the opinion item "I can easily find organic products" ($\bar{X}$= 3,11); "I am not sure about the opinion item "I find the variety of organic products sufficient" ($\bar{X}$ = 2,80); I am not sure about the opinion item "there is no difference between natural products and organic products"

($\bar{X}$ = 2,78); I disagree with the opinion item "non-organic products are harmful to health" ($\bar{X}$ = 2,44); I disagree with the opinion item "I think organic product inspections are sufficient" ($\bar{X}$ = 2,43) and I disagree with the opinion item "I know the control and inspection processes of organic products" ($\bar{X}$ = 2,07).

Findings Regarding the Reasons of Pre-service Science Teachers for Preferring Organic Food

The findings related to the importance levels of the reasons why science teachers prefer organic food products are given in Table 13.

Table 13. Findings related to the importance levels of the reasons for preference of pre-service science teachers for organic food products

List the reasons for preferring organic products according to their importance	Most cheked option	Frequency	Percentage
Tasty	1	36	34,2
Does not contain any chemical, hormone and pesticide residues	2	27	25,9
Organic products are natural and additive-free	3	19	18,1
Hygienic and healthy	4	15	14,1
Certified and controlled	5	9	7,7
TOTAL		106	100,0

When Table 13 is examined, it is seen that according to the pre-service teachers, the most important reasons for their preference for organic food are that organic products are delicious (34.2%), do not contain any chemical, hormone and pesticide residues (25.9%), organic products are natural and additive-free (18.1%), hygienic and healthy (14.1%) and certified and controlled (7.7%).

CONCLUSION

In parallel with the development and change in the world, organic agriculture and good agricultural practices are on the rise. Today, people want to lead a healthier and better quality life and they turn to natural and healthy products while meeting one of their most basic needs, nutrition. Especially with the increase in education and income levels in developed countries, the issue of food safety is becoming more important and people make more conscious choices when choosing the food they will consume. In this process, it has become inevitable to turn to organic food products that are free from chemicals or minimized the level of chemicals they contain, every stage of which is recorded from the field to the table, and produced under conditions that do not harm nature, human and other living things. Parents who want their children to eat healthier are turning to such products. Organic agricultural products are becoming more and more popular both in the world and in Turkey due to these reasons.

This study was conducted to describe the perceptions and attitudes of 106 pre-service science teachers studying in the 1st, 2nd, 3rd and 4th grades of the Department of Science Teaching, Faculty of Education, Fırat University towards organic food products. The findings of the study show that pre-service science teachers generally have a positive attitude towards organic food products. The results of the study are given below:

- 92.4% of the pre-service teachers have heard the concepts of organic or ecological agriculture. However, the rate of those who know what these concepts are is 67.9%. This shows that pre-service teachers lack knowledge about organic food products.
- 31.1% of the pre-service teachers consume organic food products "very rarely". Among the reasons for not buying organic products, the most important ones are the high price (58.5%), not easy availability of products (38.5%) and insufficient product variety (29.2%).
- The most important reasons for pre-service teachers to prefer organic food are that organic products are delicious, do not contain any chemical, hormone and pesticide residues, organic products are natural and additive-free, hygienic and healthy, and certified and controlled.

In line with these results, the following suggestions were made:

- In the study, most of the pre-service teachers stated that they had heard of organic agricultural products. However, the rate of pre-service teachers who have knowledge about organic agricultural products and ecological agricultural practices is lower. This situation shows that there is not enough knowledge and awareness among pre-service teachers about the importance and benefits of organic agriculture. In this context, including informative and comprehensive content about organic agricultural products and ecological agricultural practices in media tools, especially social media, can be considered as an effective method to increase the level of knowledge and awareness of pre-service teachers on this issue. In addition, the inclusion of courses on organic agriculture and ecological agriculture in teacher training programs can also contribute to raising awareness on this issue.
- It is thought that creating areas for good agricultural practices and producing organic agricultural products in universities and organizing social activities in this direction can be effective in increasing the knowledge, perceptions and attitudes of pre-service teachers.
- In the study, it was observed that most of the pre-service teachers stated that they care about healthy nutrition. However, they stated that they do not prefer organic food products because they find the prices of organic food products high. This situation shows that although there

is an interest in organic food, prices appear to be a factor preventing consumption. In this context, it is thought that supportive policies that encourage organic food production and facilitate access to organic food products can increase organic food consumption. Within the scope of such policies, different practices such as tax reductions, subsidies and awareness-raising activities for organic food can be implemented. In addition, regulations for the provision of organic food in schools and universities can also contribute to raising awareness on this issue.

- In the study, most of the pre-service teachers stated that it is not easy to access organic food products. This situation is due to factors such as the high interest in organic food, insufficient availability of products in the markets and difficulties in geographical access. In this context, it is thought that access to organic food products can be facilitated by ensuring the sale of organic food products in market chains and offering sales opportunities on online platforms. Market chains allocating more space to organic food and offering a variety of products may increase consumers' interest and demand for these products. In addition, the possibility of ordering organic food through online platforms can provide access to all consumers regardless of geographical location.

REFERENCE

Akın, G. (2014). İnsan sağlığı ve çevre etkileşimi. *Ankara Üniversitesi Dil ve Tarih-Coğrafya Fakültesi Dergisi*, 54(1), 105-116.

Ardoğan, R. (2012). Tüketim, nüfus ve çevre sorunları: Orantısız denklem. *Tarih, Kültür ve Sanat Araştırmaları Dergisi*, 1(Özel Sayı), 81-106.

Aydın, N. & Göze Kaya, D., (2022), Çevre sorunları ve çözüm arayışları. *Sosyal ve Beşeri Bilimler Dergisi,* 14(2), 197-215.

Ayla, D., Altıntaş, D. (2017). Organik üretim ve pazarlam sorunları üzerine bir değerlendirme. *Kastamonu Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi,* 19(4), 7-17.

Bağır, M., Karakoyun, G.Ö. & Asiltürk, E. (2022). Views of science teachers on the use of artificial intelligence in education. *International Online Journal of Educational Sciences,* 14, 1223 – 1234.

Başal, H.A., Özen, R. & Bağçeli-Kahraman, P. (2015). Üniversite öğrencileri için çevre duyarlılığı ölçeği uyarlama çalışması. *The Journal of Academic Social Science Studies JASSS*, 35, 13-23.

Bloch-Dano, E. (2015). *Sebzelerin Efsanevi Tarihi.* Ruhun Gıdası Kitaplar, İstanbul.

Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, Ö.E., Karadeniz, Ş. & Demirel, F. (2020). *Bilimsel Araştırma Yöntemleri*. Pegem Akademi, Ankara.

Cohen, L., Manion, L. & Morrison, K. (2007). *Research Methods in Education.* New York: Routledge.

Creswell, J. V. (2017). Araştırma Deseni Nitel, Nicel ve Karma Yöntem Yaklaşımları. (M. Bütün, Çev.). *Araştırma Yaklaşımının Seçimi*. S. B. Demir (Çev. Ed.). Eğiten Kitap Yayıncılık.

Çabuk, S. & Nakıboğlu M.A.B. (2003). Çevreci pazarlama ve tüketicilerin çevreci tutumlarının satın alma davranışlarına etkileri ile ilgili bir uygulama. *Çukurova Üniversitesi Sosyal Sosyal Bilimler Enstitüsü Dergisi,* 12(12), 39-54.

Çelik, R., Karakoyun, G.Ö. & Asiltürk, E. (2022). Evaluation of middle school 7th grade science skill-based questions according to the revised Bloom taxonomy. *International Online Journal of Educational Sciences*, 14, 705-716.

Çoban, O. & Şahbaz Kılınç, N. (2016). Enerji kullanımının çevresel etkilerinin incelenmesi. *Marmara Coğrafya Dergisi*, 33, 589-606.

Değirmenci, B. (2020). Çevresel bilinç ile çevresel bağlılık ilişkisinin "demografik özellikler" bağlamında incelenmesi. *Balkan and Near Eastern Journal of Social Sciences BNEJSS*, 06(04), 1-13.

Erkal, S. & Yılmaz, N. (2018). Hacettepe Üniversitesi personelinin çevreye yönelik duyuşsal eğilimleri. *2nd International Congress of Eurasian Social Sciences ICOESS*, 4-7 Nisan 2018, Side, Antalya.

Haddad, L., Hawkes, C., Waage, J., Webb, P., Godfray, C. & Toulmin, C. (2016). Food systems and diets: Facing the challenges of the 21st century, Erişim Adresi: https://glopan.org/sites/default/files/ForesightReport.pdf, Erişim Tarihi: 01.07.2024.

Hasançebi, E.B. (2010). *Öğretmenlerin Organik Gıdalar Tercih Etme Durumlarının Saptanması.* Yüksek Lisans Tezi. Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara.

Horozal, N. (2022). *Ortaokul öğrencilerinin çevre sorunlarına yönelik tutumları.* Yüksek Lisans Tezi, Zonguldak Bülent Ecevit Üniversitesi Sosyal Bilimler Enstitüsü, Zonguldak.

Karakaya, İ. (2012). Bilimsel Araştırma Yöntemleri. A. Tanrıöğen (Edt.) *Bilimsel Araştırma Yöntemleri*. Anı Yayıncılık, Ankara.

Karakoyun G.Ö. & Asiltürk, E. (2020a). Analysis of pre-service science teachers' heuristic reasoning processes about hydrogen bonding. *Journal of Science Learning,* 4, 50 – 60.

Karakoyun G.Ö. & Asiltürk, E. (2021). The Role of Heuristics in the Reasoning Process of Pre-Service Science Teachers on the "Chemical Structure – Acidity/Basicity Relationship" Topic, *Acta Chimica Slovenica,* 68, 645 – 657.

Karakoyun G.Ö. & Asiltürk, E. (2022). The Effect of Heuristics on the Reasoning of the Pre-Service Science Teachers on the Topic of Melting and Boiling Point, *Acta Chimica Slovenica,* 69, 60 – 72.

Karakoyun, G.Ö. & Asiltürk, E. (2020b). Fen Bilgisi Öğretmen Adaylarının Akıl Yürütme Süreçlerinde Höristiklerin Rolü: Bileşiklerin Çözünürlüklerine Göre Sıralanması. *Tarih Okulu Dergisi,* 13, 2607 – 2635.

Karakuş, N., Özer, Ö., Ardahanlıoğlu, Z.R., Çinar, İ. & Selim, S. (2016). Fethiye halkının çevre sorunlarına ilişkin görüşlerinin cinsiyet değişkenine göre değerlendirilmesi. *I. Uluslararası Akademik Araştırmalar Kongresi*, 3 - 05 Kasım 2016, ss.1644-1649.

Karasar, N. (2019). *Bilimsel Araştırma Yöntemi*. Nobel Akademik Yayıncılık, Ankara.

Karatekin, K. & Aksoy, B. (2012). Sosyal bilgiler öğretmen adaylarının çevreokuryazarlık düzeylerinin çeşitli değişkenler açısından incelenmesi. *Turkish Studies International Periodical For the Languages, Literature and History of Turkish or Turkic*, 7(1), 1423-1438.

Karatekin, K. (2011). *Sosyal Bilgiler Öğretmen Adaylarının Çevre Okuryazarlık Düzeylerinin Belirlenmesi*, Doktora Tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Kayalı, H. (2010). Sosyal bilgiler, Türkçe ve sınıf öğretmenliği öğretmen adaylarının çevre sorunlarına yönelik tutumları. *Marmara Coğrafya Dergisi,* (21), 258-268.

Kılıç, S. (2013). Örnekleme yöntemleri. *Journal of Mood Disorders*, 3(1), 44-46.

Kızılaslan, H. & Olgun, A. (2012). Türkiye'de organik tarım ve organik tarıma verilen desteklemeler. *Gaziosmanpaşa Üniversitesi Ziraat Fakültesi Dergisi,* 1-12.

Milli Eğitim Bakanlığı, (2005). *Fen ve Teknoloji Dersi Öğretim Programı*. Ankara.

Milli Eğitim Bakanlığı, (2013). İlköğre*tim Kurumları Fen Bilimleri Dersi Öğretim Programı.* Ankara.

Nasırlı, A. D. (2019). Organik Gıda Ürünleri ve İyi Tarım Ürünlerine İlişkin Tüketici Algı ve Tutumları: Antalya Örneği. *Yüksek Lisans Tezi*, *Akdeniz Üniversitesi Sosyal Bilimler Enstitüsü, İktisat Gıda İşletmeciliği Anabilim Dalı*. Antalya.

Özdenk Demir, G. (2021). *Geç Dönem Adolesanların Gıda Ve Beslenme Okuryazarlığı Düzeylerini Saptamaya Yönelik Yeni Bir Ölçek Geliştirme: Gıda Ve Beslenme Okuryazarlığı Ölçeği-Geçerlik Ve Güvenirlik Çalışması*, Doktora Tezi, İnönü Üniversitesi, Sağlık Bilimleri Enstitüsü, Malatya.

Özgür, E.M. (2017). Nüfus dinamikleri, çevre ve sürdürülebilirlik. *Coğrafi Bilimler Dergisi*, 15(1), 1-26.

Pe'er, S., Goldman, D. & Yavetz B. (2007). Environmental literacy in teacher training: attitudes, knowledge, and environmental behavior of beginning students, *The Journal of Envıronmental Educatıon,* 39 (1), 45-59.

Polat, M. & Önal Karakoyun, G. (2022). Studies on "Conceptual Profile" in Science Education. *International Conference on Economics&Social Sciences*. 21-23 October 2022. Antalya, Turkey.

Sezerel, H., (2018). Yiyecek İçecek İşletmelerinde Yönetim Süreci. *Yiyecek İçecek Yönetimi* (pp.22-37), İçinde (Ed.: Hakan Sezerel, Murat Doğdubay), Anadolu Üniversitesi Yayınevi, Eskişehir.

T.C. Sağlık Bakanlığı. (2015). *Türkiye Beslenme Rehberi (TÜBER)*. 20, Ankara.

TBSA. (2019). *Türkiye Beslenme ve Sağlık Araştırması (TBSA).* TC Sağlık Bakanlığı Yayınları, Ankara.

Uzun, N. (2007). *Ortaöğretim Öğrencilerinin Çevreye Yönelik Bilgi Ve Tutumları Üzerine Bir Çalışma*. Doktora Tezi, Hacettepe Üniversitesi Fen Bilimleri Enstitüsü, Ankara.

Varol, M. (2022). *8. Sınıf Öğrencilerinin Çevre İlgileri ve Sürdürülebilir Yaşama Yönelik Farkındalıkları: Eyyübiye Örneği*, Yüksek Lisans Tezi, Eskişehir Osmangazi Üniversitesi Eğitim Bilimleri Enstitüsü, Eskişehir.

Yenigün, İ. & Tuğalan, E. (2021). Geçmişten geleceğe "çevre tarihi". *Sürdürülebilir Çevre Dergisi*, 1(1), 31-36.

Yılmaz, M. (2020). *Gıda Okuryazarlığı: Bileşenlerin Tespiti, Tanımlanması Ve Öğretim Programlarındaki Yeri.* Doktora Tezi, Bolu Abant İzzet Baysal Üniversitesi Eğitim Bilimleri Enstitüsü, Bolu.

STEP TO A SUSTAINABLE FUTURE: SCIENCE TEACHERS' INTEREST IN THE ENVIRONMENT

Mehmet Polat[1]

ABSTRACT

The aim of this study is to determine science teachers' interest in the environment. The sample of the study consists of 96 science teachers working in public secondary schools in Elazığ province in the 2023-2024 academic year. In the research, descriptive survey model was used among the survey models. The data of the study were collected with quantitative data collection tools. "Personal Information Form" and "Scale of Affective Dispositions towards the Environment" were used as data collection tools to determine the demographic characteristics of science teachers regarding gender, age and professional seniority. The data obtained from the measurement tools were transferred to the SPSS package programme and descriptive analyses and parametric tests were performed. As a result of the research, it was determined that pre-service science teachers' environmental interests were at a high level; their environmental interests differed significantly depending on their gender and this difference was in favour of female teachers; there was no significant relationship between teachers' environmental interests and their age and professional seniority.

Keywords: Science, Environmental Interest, Environmental Attitude, Environmental Behaviour, Environmental Problems

INTRODUCTION

The interaction between humans and the natural environment has been a complex and dynamic phenomenon since the beginning of human life on earth. This interaction has developed within the framework of a mutual balance throughout the historical process and has established a deep connection between the welfare of humanity and the functioning of natural systems

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(Akın, 2014: 105-106). Early human societies existed in harmony with nature by adopting a hunter-gatherer lifestyle. In this period, human activities were within the carrying capacity of natural systems and did not cause significant damage to the environment (Yenigün & Tuğalan, 2021: 35). However, with the acceleration of industrialisation and technological developments in the 20th century, the relationship between humans and the environment has undergone a dramatic change. Rapid population growth, urbanisation and intensive resource use have put pressure on natural systems, leading to a deterioration in the balance (Özgür, 2017: 2).

The world population reaching 8 billion, increasing demands, consumption-oriented economic policies encouraged by capitalism and rapid urbanisation lead to the rapid depletion of the limited resources of our world and the emergence of environmental problems (Aydın & Göze Kaya, 2022: 198). This situation is not only an academic concern, but also a harbinger of a global crisis. Population growth and the increase in related needs lead to an increase in energy demand. This demand leads to excessive use of non-renewable energy resources, which threatens both energy security and environmental balance. Today, most of the energy production is based on fossil fuels. Increasing energy demand leads to the rapid depletion of fossil fuel resources such as coal, oil and natural gas (Çoban and Şahbaz Kılınç, 2016: 590). This situation leads not only to a decrease in energy resources but also to serious environmental problems.

As stated by Karakuş et al. (2016), the solution of environmental problems does not only depend on technological developments or legal regulations. The main factor is the change in individual behaviour, that is, the increase in environmental awareness and the formation of environmental sensitivity. At this point, the importance of environmental education emerges. Our interaction with the environment, which starts in our daily life and continues at school, is organised within the scope of environmental education given in our family and systematically in schools. Environmental education is very important because it includes points such as interest and curiosity about the environment, being aware of environmental problems and feeling responsible for them, using natural resources economically and ensuring the continuity of resources, and developing solutions to environmental problems. In our country, it is seen that the environmental issue is at an important point both for today and for the future, and the objectives related to "environment" and achievements related to "environmental education" have been included in the education programmes by the Ministry of National Education. The environment, which is included in the curricula of many courses, also has an important place in the Science Curriculum.

Science concepts are abstract and general expressions used to explain the functioning of nature (Polat, 2023; Karakoyun & Asiltürk, 2020a; Karakoyun & Asiltürk, 2020b; İlhan & Asiltürk, 2019). Science education aims to help students understand natural phenomena, develop scientific process skills, and critically evaluate scientific knowledge. At the same time, it also aims to help students acquire 21st century skills such as communication, collaboration, creativity, problem solving, problem solving, critical thinking, and digital literacy (Polat & Önal Karakoyun, 2022; Uğraş, Aydemir, & Asiltürk, 2017; Karakoyun & Asiltürk, 2021; Bağır, at all. 2022; Karakoyun & Asiltürk, 2022; Çelik, et al. 2022). In the 2005 Science and Technology Curriculum, the relationship between science, technology, society and the environment was emphasised, renewable and non-renewable energy sources and their importance were mentioned, the aim of students to recognise environmental problems and to make conscious decisions by taking responsibility for them was mentioned. But the concept of sustainable development was not mentioned (Ministry of National Education [MoNE], 2005: 9-33). In the 2013 "Primary School Science Curriculum", unlike the 2005 curriculum, the aims of developing attitudes, curiosity and interest in the events occurring in nature and developing sustainable development awareness towards natural resources were included among the main aims of the new curriculum (MoNE, 2013: II). In this context, it can be said that determining the environmental interests of science teachers, who are the implementers of the Science Curriculum, is important for the realisation of the aims of the curriculum. As a matter of fact, this study aims to determine the environmental interests of science teachers.

Purpose of the Study

In this study, it was aimed to determine the environmental interests of science teachers. For this purpose, environmental interests of science teachers working in public secondary schools in Elazığ province were analysed according to their gender, age and professional experience.

Research Model

The research was designed with analysed research methods. Quantitative research method is the testing of objective theories by considering the relationship between the variables of the research (Creswell 2017: 4). In quantitative research, variables are analysed by converting them into quantified data through measurement tools. Since the study aims to determine the environmental interests of science teachers, descriptive survey model was preferred. The descriptive survey model is defined as a research approach that aims to describe an event or situation that still exists or has occurred in the past (Karasar, 2019: 109). In this model, the event, individual or object within the scope of the research is tried to be defined within its own conditions and as it is, and no effort is made to change or influence it in any way. Descriptive research focuses on explaining events, situations or phenomena.

Working Group

The study group of this research consists of 96 science teachers working in public secondary schools in Elazığ province in the 2023-2024 academic year and who voluntarily participated in the research. The selection of the teachers participating in the study was carried out using simple random sampling method. Random sampling method is a sampling method that consists of randomly selected units from a given universe without any predetermined criteria, with equal probability of each unit being selected (Büyüköztürk, 2012). In this method, all units in the universe have an equal chance of being included in the sample and thus, it is acceptable that the research findings represent the universe (Karasar, 2019: 115).

Data Collection Tools

In this study, the "Scale of Affective Dispositions towards the Environment" developed by the Wisconsin Centre for Environmental Education and adapted into Turkish by Karatekin (2011) was used as a data collection tool. This scale consists of two main parts:

Demographic Information: This section includes teachers' demographic information such as gender, age and professional seniority.

Environmental Interest: In this section, there are 27 items to measure the environmental interest levels of science teachers. The items are presented on a 5-point Likert-type scale and are evaluated between 1 ("Strongly Disagree") and 5 ("Strongly Agree").

The Cronbach Alpha reliability coefficient of the scale adapted by Karatekin (2011) was found to be 0.78. This value shows that the scale has a high internal consistency. Aksoy and Karatekin (2011) divided the affective disposition levels towards the environment into 5 categories:

Very Low : 1.80 and below

Low : 1.81 - 2.60

Medium : 2,61 - 3,40

High : 3,41 - 4,20

Very High : 4.21 - 5.00

Data Collection

The current study covers science teachers working in secondary schools affiliated to the Ministry of National Education in Elazığ province in the 2023-2024 academic year. The link created by converting the "Personal Information Form" prepared by the researcher and the "Scale of Affective

Dispositions towards the Environment" adapted into Turkish by Karatekin (2011) into digital forms was sent to the participants from the Elazığ science class WhatsApp group. In the explanation section on the first page of the data collection tool, the subject and purpose of the research were explained and it was clearly stated that the participation was voluntary, the data collected from the teachers would not be used for any purpose other than this study and that their answers would remain confidential.

Analysing the Data

The data obtained were analysed using SPSS package programme. Demographic findings were presented with frequency and percentage distributions. Scale items were defined with arithmetic mean and standard deviation statistics in addition to percentage distributions. In the comparison of science teachers' environmental interests according to their individual characteristics, t-test was used for two groups and analysis of variance (ANOVA) was used for more than two groups.

RESULTS

Findings Related to Demographic Characteristics of Science Teachers

The findings related to the demographic characteristics of the science teachers who participated in the study are given in Table 1.

Table 1. Demographic characteristics of the participants

Gender	Groups	Frequenc	Percentage
Gender	Male	54	56,3
	Female	42	43,7
	TOTAL	96	100,0
Age	18-25 years	19	19,8
	26-35 years	32	33,3
	36-45 years	27	28,1
	46 years and over	18	18,8
	TOTAL	96	100,0
Professional seniority	1-5 years	23	23,9
	6-10 years	17	17,7
	11-15 years	28	29,2
	16-20 years	16	16,7
	21 years and over	12	12,5
	TOTAL	96	100,0

When Table 1 is analysed, it is seen that 56,3% of the teachers participating in the study are male and 43,7% are female; 33,3% are 26-35 years old, 28,1% are 36-45 years old, 18,8% are 18-25 years old and 18,8% are 46 years old and above; 29,2% of them have 11-15 years, 23,9% of them have 1-5 years, 17,7% of them have 6-10 years, 16,7% of them have 16-20 years and 12,5% of them have 21 years or more of professional seniority.

Findings Related to Environmental Interests of Science Teachers

The mean scores of the science teachers participating in the study regarding the items of the Affective Dispositions towards the Environment Scale and the overall scale are given in Table 2.

Table 2. Mean scores of science teachers' environmental interests

Items	*X*	ss
1. I like watching television programmes about the environment.	4,14	0,59
2. I think that there is (is) not much I can do to solve environmental problems.	4,39	0,68
3. I am not interested in reading about the environment (I am)	3,97	0,74
4. I like listening to the sounds of animals such as birds and insects.	4,28	0,52
5. I think that most of the concerns about environmental problems are exaggerated (not exaggerated).	3,81	0,79
6. I think it is important for me to know environmental problems and issues.	4,26	0,83
7. I am interested in the issue of deforestation.	4,42	0,75
8. I think that the damage to the ozone layer is an issue that everyone should be interested in	3,94	0,67
9. I think that industry and agriculture should be controlled more to protect the environment, even if the things I buy cost more.	3,56	0,85
10. I am not interested in the increasing size of deserts in the world (I am).	4,01	0,39
11. I think there are enough laws to protect the environment	3,23	0,46
12. I believe that I can contribute to the solution of environmental problems with my activities.	4,12	0,51
13. I oppose (do not oppose) any environmental regulation that limits my freedom.	3,24	0,45
14. More space should be allocated for wildlife areas.	3,59	0,66
15. Environmental restrictions should (should not) be removed in order to increase the exploration, production and utilisation of fossil fuels.	4,25	0,49
16.I think that what I do is not very effective on the quality of the environment.	3,10	0,67
17. The government should subsidise research and development related to renewable energy, even if it leads to higher taxes.	3,74	0,55
18. I am interested in how much waste is produced in Turkey.	4,06	0,48
19. Legislation should be passed and enacted that protects the quality of future life even if it leads to the restriction of individual freedoms.	3,91	0,73
20. I am not interested in the rate of extinction of species in the world (I am).	4,31	0,60
21. I am interested in environmental health problems caused by air or water pollution.	4,37	0,64
22. I want to help solve environmental problems.	4,13	0,81
23. I think it is very difficult to change my friends' opinions about doing something about the environment (e.g. recycling).	4,55	0,43
24. I usually do not (do) notice natural assets such as flowers, trees and clouds around me.	4,43	0,57
25. I think it is my responsibility to help solve environmental problems	4,29	0,53
26. If a person's car exceeds certain standards for air pollution, he/she should not be allowed to drive that car.	4,16	0,62
27. I think that individual efforts can contribute to the solution of environmental problems.	3,88	0,70
ENVIRONMENTAL INTEREST	**4,01**	**0,62**

In order to calculate the environmental interest scores of science teachers, the negative items in the scale were reverse coded and the positive statements related to these items were put in brackets and shown in Table 2.

When Table 2 is analysed, it is seen that science teachers stated "I think it is very difficult to change my friends' opinions about doing something about the environment (e.g. recycling)" ($\overline{X}$ = 4,55); "I usually do not (do) notice natural assets such as flowers, trees and clouds around me" ($\overline{X}$ = 4,43); "I am interested in the destruction of forests. " ($\overline{X}$ = 4,42); "I think that there is not much I can do to solve environmental problems" ($\overline{X}$ = 4,39); "I am interested in environmental health problems caused by air or water pollution" ($\overline{X}$ = 4,37); "I am not interested in the rate of extinction of species in the world" ($\overline{X}$ = 4,31); "I think it is my responsibility to help solve environmental problems" ($\overline{X}$ = 4,29); "I like listening to the sounds of animals such as birds and insects" ($\overline{X}$ = 4,28); "I think it is important for me to know about environmental problems and issues" ($\overline{X}$ = 4,26) and "Environmental restrictions should (should not) be removed in order to increase the research, production and utilisation of fossil fuels" ($\overline{X}$ = 4,26). ($\overline{X}$ = 4,55) were at a very high level.

When Table 2 was analysed, it was found that science teachers' interest in the items "13. I oppose (do not oppose) any kind of environmental regulation that limits my freedom" ($\overline{X}$ = 3,24); "11. I think there are enough laws to protect the environment" ($\overline{X}$ = 3,23) and "I think that what I do is not very effective on the quality of the environment" ($\overline{X}$ = 3,10) was at a moderate level.

When Table 2 was analysed, it was seen that science teachers' interest in the other items in the scale was at a high level. The table also shows that science teachers' general interest in the environment is at a high level (X = 4,01).

Comparison of Science Teachers' Environmental Interests According to Their Gender

The environmental interests of the teachers participating in the study were compared according to their gender, age and professional seniority and the findings are given in Table 3.

Table 3. Comparison of participants' environmental interests according to their gender

	Gender	n	$\overline{X}$	ss	Levene's Test		sd	t	p
					F	p			
Environmental interest	Male	54	3,78	0,42	21,794	0,217	94	**-2,794**	**0,011***
	Female	42	4,24	0,61					

When Table 3 was analysed, it was determined that the environmental interest levels of science teachers differed statistically significantly according to their gender [t(94)= -2,794; p<.05]. While the environmental interest of male teachers was at the "High" level ($\bar{X}$= 3,78), the environmental interest of female teachers was close to the "High" level but at the "Very High" level.

Comparison of Science Teachers' Environmental Interests According to Their Age

The environmental interests of the teachers participating in the study were compared according to their ages and the findings are given in Table 4.

Table 4. Comparison of participants' environmental interests according to their ages

	Age	n	$\bar{X}$	s.s	ANOVA TESTİ					
					Var. Kay.	**Kar. Top.**	**sd**	**Kar. Ort.**	**F.**	**p**
Env. Interest.	18-25 years (a)	19	4,39	0,74	Between Group	6,00	3			
	26-35 years (b)	32	3,86	0,46	In Group	20,871	92			
	36-45 years (c)	27	3,52	0,57	Total	21,779	96	2,521	4,371	0,237
	46 years and over (e)	18	4,27	0,71						
	Toplam	96	4,01	0,62						

According to the findings in Table 4, there was no statistically significant difference between the participant teachers' environmental interests and their ages [F(3-92) = 4,371; p>.05]. When the arithmetic averages of the groups are analysed, it is seen that the highest arithmetic mean score belongs to the teachers aged 18-25 ($\bar{X}$= 4,39) and the lowest arithmetic mean score belongs to the teachers aged 36-45 ($\bar{X}$= 3,52). According to the findings of the research, it is seen that the environmental interests of individuals in the age groups of 18-25 years and 46 years and over are at a "very high" level, while the environmental interests of science teachers in the age groups of 26-35 years and 36-45 years are at a "high" level.

Comparison Of Environmental Interests Of Science Teachers According To Their Ages

The environmental interests of the teachers participating in the study were compared according to their professional seniority and the findings are given in Table 5.

Table 5. Comparison of participants' environmental interests according to their professional seniority

	Year	n	$\bar{X}$	s.s	ANOVA TEST					
					Var. Kay.	**Kar. Top.**	**sd**	**Kar. Ort.**	**F.**	**p**
Env. Interest.	1-5 year	23	3,86		Between Group	6,00	4			
	6-10 year	17	4,26		Within Group	13,198	92			
	11-15 year	28	3,72		Total	16,359	96	1,988	2,415	0,362
	16-20 year	16	3,99							
	21 year and over	12	4,22							
	TOPLAM	96	4,01	0,62						

According to the findings in Table 5, there was no statistically significant difference between science teachers' environmental interests and their professional seniority [F(4-92) = 2,415; p>.05]. When the arithmetic means of the groups are analysed, it is seen that the highest arithmetic mean score belongs to the teachers with 6-10 years of professional seniority ($\bar{X}$ = 4,26) and the lowest arithmetic mean score belongs to the teachers with 11-15 years of professional seniority ($\bar{X}$ = 3,72). According to the findings of the research, the environmental interests of teachers with 6-10 years and 21 years or more of professional seniority were found to be at a "very high" level, while the environmental interests of science teachers with 1-5 years and 11-15 years of professional seniority were found to be at a "high" level.

DISCUSSION AND CONCLUSION

Environmental problems are one of the most important global issues of our time. Raising conscious and sensitive individuals is of great importance for the solution of these problems. In this context, it is of critical importance that educators are environmentally conscious and can transfer this awareness to their students. This study aimed to investigate the sensory tendencies of science teachers working in public middle schools in Elazığ province towards the environment. In line with this purpose, the "Environmental Sensory Tendencies Scale" was applied to science teachers working in public middle schools in Elazığ province and the obtained data were evaluated.

The study found that science teachers had a high interest in issues such as "influencing friends on environmental issues", "noticing natural beauties", "destruction of forests", "solution of environmental problems", "air and water pollution", "endangered species", "environmental responsibility", "listening to the sounds of nature", "being environmentally conscious", and "limiting fossil fuels". However, teachers' interest in issues such as "opposing environmental regulations", "inadequacy of environmental protection laws", and "limited impact of individual actions on the environment" was moderate. This finding suggests that teachers' environmental awareness is high, but they have concerns about the inadequacy of legal regulations and the limited impact of individual efforts on some issues. Another important finding of the study is that science teachers generally have a high interest in the environment. It is thought that the inclusion of topics and kazanıms related to the natural world and environmental problems in the science curriculum, the widespread use of internet and mobile technologies, the ability to be informed about global environmental problems through social media platforms, and the widespread sharing of environmental awareness activities on social media platforms played a role in the emergence of this finding.

The study found that science teachers' environmental interest levels differed significantly statistically according to their gender, and this difference was in favor of female teachers. Accordingly, it can be said that female teachers are more sensitive to environmental issues. There was no significant relationship between age and professional seniority and environmental interest level. This finding suggests that environmental consciousness and awareness is important for teachers of all ages and professional experience. The study also found that the environmental interests of teachers in the 18-25 and 46 and over age groups were "very high", while the environmental interests of teachers in the 26-35 and 36-45 age groups were "high". Similarly, it was observed that the environmental interests of teachers with 6-10 years and 21 years and over professional seniority were "very high", while the environmental interests of teachers with 1-5 years and 11-15 years professional seniority were "high". These findings suggest that young and newly started teachers may be more interested in environmental issues and that this interest may decrease over time.

There are some studies in the literature that are similar to this finding. In a study conducted with the participation of 1013 secondary school students, Uzun (2007) found that students' environmental thinking scores exhibited a mean ($\bar{X}$ = 54.72) close to "positive". Pe'er, Goldman, and Yavetz (2007) examined 765 Israeli pre-service teachers and found that their environmental attitudes were at a high level ($\bar{X}$ = 3.95). Kayalı (2010), in a study conducted with the participation of 219 Turkish pre-service teachers, found that pre-service teachers' attitudes towards environmental problems were positive. Similarly, Karatekin (2011) examined 1587 pre-service social studies teachers and found that their sensitivity towards the environment was high. Başal, Özel, and Bağçeli-Kahraman (2015) consulted the opinions of 275 university students in their adaptation research on the environmental sensitivity scale. As a result of the research, it was determined that the mean scores of the environmental sensitivity scale of university students were at a high level. Erkal and Yılmaz (2018) found that Hacettepe University employees' sensitivity towards the environment was at a medium level ($\bar{X}$ = 3.56). Horozal (2022) aimed to determine the attitudes of secondary school students towards environmental problems in his research and consulted the opinions of 580 secondary school students. As a result of the research, it was determined that the mean scores of the environmental attitude scale of secondary school students were at a high level and their environmental attitudes did not differ significantly according to their demographic characteristics. Varol (2022), in his research aiming to determine the environmental interests and awareness levels of 8th grade students in Şanlıurfa province towards sustainable living, consulted the opinions of 541 students. As a result of the research, it was determined that the environmental interests of the participants were at a moderate level; the environmental interests of the students differed significantly depending on their gender and this difference was in favor of female students; there was no statistically significant difference between the environmental interests of the participants and other demographic characteristics. Çobur and Başel (2023) examined the relationship between global climate change and renewable energy awareness, and consulted the opinions of 252 adult individuals. Karabulut (2023) investigated the awareness of teachers working in public schools in Adana towards global climate change. As a result of the research in which 271 teachers were interviewed, it was determined that the awareness levels of teachers were high. As a result of the research, it was determined that the global climate change awareness of the participants was at a medium level; there was no statistically significant difference between the global climate change awareness of the participants and their gender, age and education levels. In this context, it can be said that this finding of the study is similar to the findings of the studies in the literature." translate the text into English in an academic language and style

REFERENCES

Akın, G. (2014). İnsan sağlığı ve çevre etkileşimi. *Ankara Üniversitesi Dil ve Tarih-Coğrafya Fakültesi Dergisi*, 54(1), 105-116.

Ardoğan, R. (2012). Tüketim, nüfus ve çevre sorunları: Orantısız denklem. *Tarih, Kültür ve Sanat Araştırmaları Dergisi*, 1(Özel Sayı), 81-106.

Aydın, N. & Göze Kaya, D., (2022), Çevre sorunları ve çözüm arayışları. *Sosyal ve Beşeri Bilimler Dergisi,* 14(2), 197-215.

Bağır, M., Karakoyun, G.Ö. & Asiltürk, E. (2022). Views of science teachers on the use of artificial intelligence in education. *International Online Journal of Educational Sciences,* 14, 1223 – 1234.

Başal, H.A., Özen, R. & Bağçeli-Kahraman, P. (2015). Üniversite öğrencileri için çevre duyarlılığı ölçeği uyarlama çalışması. *The Journal of Academic Social Science Studies JASSS*, 35, 13-23.

Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, Ö.E., Karadeniz, Ş. & Demirel, F. (2020). *Bilimsel Araştırma Yöntemleri*. Pegem Akademi, Ankara.

Creswell, J. V. (2017). Araştırma Deseni Nitel, Nicel ve Karma Yöntem Yaklaşımları. (M. Bütün, Çev.). *Araştırma Yaklaşımının Seçimi*. S. B. Demir (Çev. Ed.). Eğiten Kitap Yayıncılık.

Çelik, R., Karakoyun, G.Ö. & Asiltürk, E. (2022). *Evaluation* of Middle School 7th Grade Science Skill-Based Questions According to the Revised Bloom Taxonomy. *International Online Journal of Educational Sciences,* 14, 705-716.

Çoban, O. & Şahbaz Kılınç, N. (2016). Enerji kullanımının çevresel etkilerinin incelenmesi. *Marmara Coğrafya Dergisi*, 33, 589-606.

Değirmenci, B. (2020). Çevresel bilinç ile çevresel bağlılık ilişkisinin “demografik özellikler” bağlamında incelenmesi. *Balkan and Near Eastern Journal of Social Sciences BNEJSS*, 06(04), 1-13.

Erkal, S. & Yılmaz, N. (2018). Hacettepe Üniversitesi personelinin çevreye yönelik duyuşsal eğilimleri. *2nd International Congress of Eurasian Social Sciences ICOESS*, 4-7 Nisan 2018, Side, Antalya.

Horozal, N. (2022). *Ortaokul öğrencilerinin çevre sorunlarına yönelik tutumları.* Yüksek Lisans Tezi, Zonguldak Bülent Ecevit Üniversitesi Sosyal Bilimler Enstitüsü, Zonguldak.

İlhan, G. & Asiltürk, E. (2019). Fen bilgisi öğretmeni adaylarının bazı kimya konularında akıl yürütmelerinin incelenmesi. *Bayburt Eğitim Fakültesi Dergisi*, 14, 391-417

Karabulut, N. (2023). Öğretmenlerin küresel iklim değişikliğine yönelik farkındalıklarının değerlendirilmesi. *Ulusal Eğitim Dergisi*, 3(2), 265-294.

Karakoyun G.Ö. & Asiltürk, E. (2020a). Analysis of pre-service science teachers’ heuristic reasoning processes about hydrogen bonding. *Journal of Science Learning*, 4, 50 – 60.

Karakoyun, G.Ö. & Asiltürk, E. (2020b). Fen Bilgisi Öğretmen Adaylarının Akıl Yürütme Süreçlerinde Höristiklerin Rolü: Bileşiklerin Çözünürlüklerine Göre Sıralanması. *Tarih Okulu Dergisi*, 13, 2607 – 2635.

Karakoyun G.Ö. & Asiltürk, E. (2021). The Role of Heuristics in the Reasoning Process of Pre-Service Science Teachers on the “Chemical Structure – Acidity/Basicity Relationship” Topic, *Acta Chimica Slovenica*, 68, 645 – 657.

Karakoyun G.Ö. & Asiltürk, E. (2022). The Effect of Heuristics on the Reasoning of the Pre-Service Science Teachers on the Topic of Melting and Boiling Point, *Acta Chimica Slovenica*, 69, 60 – 72.

Karakuş, N., Özer, Ö., Ardahanlıoğlu, Z.R., Çinar, İ. & Selim, S. (2016). Fethiye halkının çevre sorunlarına ilişkin görüşlerinin cinsiyet değişkenine göre değerlendirilmesi. *I. Uluslararası Akademik Araştırmalar Kongresi*, 3 - 05 Kasım 2016, ss.1644-1649.

Karasar, N. (2019). *Bilimsel Araştırma Yöntemi*. Nobel Akademik Yayıncılık, Ankara.

Karatekin, K. & Aksoy, B. (2012). Sosyal bilgiler öğretmen adaylarının çevreokuryazarlık düzeylerinin çeşitli değişkenler açısından incelenmesi. *Turkish Studies International Periodical For the Languages, Literature and History of Turkish or Turkic*, 7(1), 1423-1438.

Karatekin, K. (2011). *Sosyal Bilgiler Öğretmen Adaylarının Çevre Okuryazarlık Düzeylerinin Belirlenmesi*, Doktora Tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Kayalı, H. (2010). Sosyal bilgiler, Türkçe ve sınıf öğretmenliği öğretmen adaylarının çevre sorunlarına yönelik tutumları. *Marmara Coğrafya Dergisi,* (21), 258-268.

Milli Eğitim Bakanlığı, (2005). *Fen ve Teknoloji Dersi Öğretim Programı*. Ankara.

Milli Eğitim Bakanlığı, (2013). İlköğre*tim Kurumları Fen Bilimleri Dersi Öğretim Programı.* Ankara.

Özgür, E.M. (2017). Nüfus dinamikleri, çevre ve sürdürülebilirlik. *Coğrafi Bilimler Dergisi*, 15(1), 1-26.

Pe'er, S., Goldman, D. & Yavetz B. (2007). Environmental literacy in teacher training: attitudes, knowledge, and environmental behavior of beginning students, *The Journal of Envıronmental Educatıon,* 39 (1), 45-59.

Polat, M. (2023). Syllogistic Reasoning and Studies on Syllogistic Reasoning In Science Education. (s. 173-184). *International Conference on Economics&Social Sciences*, June, 26-27, 2023. Bucharest, Romania.

Uğraş, M., Aydemir, S. & Asiltürk, E. (2017). Analysis of pre-service science teachers level of associating their chemistry knowledge with Daily life and the relationship between these levels and their attitudes towards teaching science. *International Journal of Human Sciences*, 14, 4359-4545.

Uzun, N. (2007). *Ortaöğretim Öğrencilerinin Çevreye Yönelik Bilgi Ve Tutumları Üzerine Bir Çalışma*. Doktora Tezi, Hacettepe Üniversitesi Fen Bilimleri Enstitüsü, Ankara.

Varol, M. (2022). *8. Sınıf Öğrencilerinin Çevre İlgileri ve Sürdürülebilir Yaşama Yönelik Farkındalıkları: Eyyübiye Örneği*, Yüksek Lisans Tezi, Eskişehir Osmangazi Üniversitesi Eğitim Bilimleri Enstitüsü, Eskişehir.

Yenigün, İ. ve Tuğalan, E. (2021). Geçmişten geleceğe "çevre tarihi". *Sürdürülebilir Çevre Dergisi*, 1(1), 31-36.

AN INVESTIGATION OF PRE-SERVICE SCIENCE TEACHERS' SELF-EFFICACY FOR USING MATHEMATICS IN SCIENCE TEACHING PROCESS

Erol Asiltürk[1]

SUMMARY

Science and mathematics are two disciplines that complement and strengthen each other. Science teachers need to be able to use mathematics effectively for effective teaching. The purpose of this study is to examine pre-service science teachers' self-efficacy perceptions towards using mathematics in science teaching. The study was designed with relational survey method, one of the quantitative research methods. The study group consisted of 117 pre-service science teachers studying in the 1st, 2nd, 3rd and 4th grades of Science Teacher Education at Fırat University Faculty of Education. "Self-Efficacy Scale for the Use of Mathematics in Science" was used as a data collection tool. Data were analysed by descriptive analysis and parametric tests. The findings of the study showed that pre-service science teachers' self-efficacy perceptions towards using mathematics in science teaching were at a high level. It was determined that pre-service science teachers' self-efficacy perceptions did not show a statistically significant difference according to gender, grade level and mathematics grade point average.

Keywords: Pre-service Science Teachers, Self-efficacy Perception, Science Teaching, Using Mathematics

INTRODUCTION

Although education systems vary in different countries, today's global challenges lead to the globalisation of educational problems. In this context, the contemporary understanding of education sets common goals for the whole world. These goals can be summarised as learning to learn, learning

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to do, learning to live together and learning to produce and use solutions to problems. Research shows that education requires the development of new understandings and teaching approaches with new technologies. This situation necessitates a methodological transformation that goes beyond producing content for new technological environments and requires a complete change in concepts and understandings about teaching (Flogie & Aberšek, 2015; İç & Tutak, 2018). Global problems such as climate change, health inequalities and social problems make it necessary for disciplines to work together and develop an interdisciplinary understanding. In this way, solutions to problems can be produced with perspectives that go beyond disciplines. In education, when it comes to complex real-world problems, pedagogical methods such as problem-based learning, case studies, field studies, discovery or inquiry learning come to the fore (Klaassen, 2018). However, the ineffective application of these pedagogical methods and insufficient understanding of the underlying educational philosophy is one of the main reasons for the lack of solutions to various social problems experienced in the last century. Therefore, the integration of disciplines in different ways and the relationship between educational philosophies and methods need to be reconsidered.

Teaching, which is one of the cornerstones of education, is built on three foundations: general aptitude, general culture and subject knowledge education. The training of teachers and improving their qualifications is one of the most emphasised issues in Turkey. However, the dynamic structure of the teaching profession makes it difficult to create a permanent structure in the search for qualifications. The development of science and the change in technology are rapidly transforming individuals and society, which leads to changes in the goals of education and the roles of teachers (İlhan et al., 2020; Aydoğdu, Cevizci, & Tutak, 2022; İlhan & Tutak, 2021). Nowadays, it has become more important for students to have analytical and higher-level thinking skills rather than getting high grades and being successful in exams (Celik et. All, 2022; Bağır, 2022). For this reason, there are many studies in the literature that examine students' reasoning from different aspects (Karakoyun & Asiltürk, 2020a; Karakoyun & Asiltürk, 2020b; Karakoyun & Asiltürk, 2021; Karakoyun & Asiltürk, 2022). In this context, it can be said that modern education systems need teachers who will enable students to transfer the knowledge they have acquired to their daily lives by preparing an interdisciplinary learning-teaching environment in the process of educating students with 21st century skills.

Integration of disciplines is a very common situation in recent years. Especially considering the structure of science and mathematics fields, the integration of these disciplines can be considered as a very common situation in educational studies. The desire to include the STEM education approach in today's curricula is also effective in the emergence of this situation. The relationship between science and mathematics has long been recognised and researched (Tian, Wu, Li, & Zhou, 2008). Not only our country's Ministry of National Education (MoNE, 2006; 2009; 2013a; 2013b), but also international organisations such as the National Council for Teacher of Mathematics (NCTM, 2000) and the National Research Council (1996) have made arrangements in curricula in order for students to be successful in science and mathematics and have emphasised the importance of an interdisciplinary approach in science and mathematics. NCTM (2000) stated that there is a very clear relationship between science and mathematics and that this relationship exists in both the content and the processes of these disciplines. When the science and mathematics curricula of our country are examined, it is seen that the basic skills such as 'critical thinking, creative thinking, research, inquiry, problem solving' are common in both curricula. Basista and Mathews (2002) stated that science provides concrete and rich content for mathematics and mathematics serves as a language and tool for understanding science concepts and applications.

Science is the systematic organisation of the knowledge that humanity has acquired as a result of its interaction with its natural environment since its arrival on earth and is a body of knowledge with proven reliability. This accumulation has played a vital role not only in meeting the needs but also in the development of societies. The contribution of technology based on science is too numerous to be counted and this situation clearly reveals the importance given to science education by developed countries today (Polat & Koç, 2024). The need for human resources trained in science for a strong and influential future further emphasises the importance of science education. Science education enables individuals to acquire knowledge on basic issues such as the world they live in, organisms, healthy life and protection of the environment. In this way, it enables them to make informed choices about vital issues such as the properties of the water they drink, the air they breathe, and the production and cooking processes of the food they eat. Science is not only a natural science, but also forms the essence of knowledge and skills that will help people understand and interpret the environment they live in and establish order in this complex environment (Deringöl & Gülten, 2016). Mathematics should not be perceived as a uniform discipline consisting of abstract concepts and strict rules. On the contrary, mathematics is a means of expression, problem generation and solving, systematic thinking, critical evaluation, and higher level cognitive skills (Aydoğdu, Erşen, & Tutak, 2014). In today's globalising world, it has become more important than ever to educate individuals with the flexibility, creativity, mathematical and technological competencies needed in changing and developing fields such as technology, engineering and economy

(Aydoğdu & Tutak, 2017). In this context, the fact that mathematics is the cornerstone of scientific progress, serves as a resource for every discipline and is included in almost all education programmes clearly shows the importance of this discipline (İlhan et al., 2020).

Science and mathematics disciplines play a critical role in understanding and explaining the complex world. Considering the strong relationship between these two fields, it is possible to create a more meaningful learning environment by integrating and integrating them. The use of mathematics in science education plays an important role in understanding concepts and grasping the basic principles of science. Therefore, high self-efficacy perceptions of pre-service science teachers towards the use of mathematics in science education constitute the basis of effective science teaching. In this context, it can be said that determining pre-service science teachers' self-efficacy perceptions about using mathematics in science teaching process is important for the integration of science and mathematics disciplines.

METHOD

Research Design

In this study, using quantitative research methods, it was aimed to examine the relationship between pre-service science teachers' self-efficacy perceptions towards the use of mathematics in science education and their mathematical literacy self-efficacy perceptions. The research is in relational survey model. "Self-Efficacy Scale for the Use of Mathematics in Science Education" and "Mathematical Literacy Self-Efficacy Scale" were used as data collection tools. The data were analysed with SPSS software (Büyüköztürk et al., 2018).

Purpose of the Study

In this study, it is aimed to determine the self-efficacy perceptions of pre-service science teachers towards using mathematics in science teaching.

Study Group

The study group of this research consists of 117 pre-service science teachers studying in the 1st, 2nd, 3rd and 4th grades of the Department of Science Teacher Education of the Faculty of Education of Fırat University in the 2023-2024 academic year and determined by the non-random sampling method. Non-random sampling method is a method in which all individuals in the research population have the chance to be included in the sample. In this method, all individuals in the research population are included in a list and the individuals to be included in the sample are randomly selected from this list (Büyüköztürk, 2018).

Data Collection Tools

In this study, Can Taşkın, Günhan Cantürk, and Erdal Öngel (2005) developed the Self-Efficacy Scale for the Use of Mathematics in Science (SPSS), which consists of 18 items, was used as a data collection tool. This scale is a five-point Likert-type scale with a high Cronbach's alpha reliability coefficient of 0.88 and consists of three sub-factors. This sub-factor measures the individual's belief in his/her mathematical abilities and confidence in his/her mathematical problem solving skills. The 5 items that make up the sub-factor are as follows:

1. Mathematical self-perception (5, 6, 7, 9, 11)
2. Application of mathematics (12, 13, 14, 15, 16, 17)
3. Mathematical skills (1, 2, 3, 4, 8, 10, 18)

The items in the scale were graded in the range of 1 (never) - 5 (always).

Data Collection

In the application phase of the study, a questionnaire form consisting of two parts was prepared. The first part included questions about the demographic characteristics of the participants, while the second part presented the Self-Efficacy Scale for the Use of Mathematics in Science (PSSEM). The questionnaire form was administered by the researcher to the pre-service teachers in the sample and the application took an average of 20 minutes. Being sensitive to the ethical dimension of the study, the participants were informed that their personal information and data would remain confidential before the application. In addition, the purpose and importance of the questionnaire were explained and the participants were asked to show the necessary care. In this way, the study was conducted in accordance with ethical principles.

Analysing the Data

SPSS package programme was used for the analysis of the data obtained in this study. The negative questions in the measurement tool were reverse coded and the scores obtained were evaluated with descriptive statistical methods and parametric analysis techniques.

FINDINGS

Findings Related to Demographic Characteristics of Prospective Teachers

Table 1. Findings related to demographic characteristics of pre-service teachers

Gender	Groups	Frequency	Percentage
Gender	Male	46	39,3
	Female	71	60,7
	TOTAL	117	100,0
Grade	1st grade	28	23,9
	2st grade	24	20,5
	3st grade	35	29,9
	4st grade	30	25,7
	TOTAL	117	100,0

According to Table 1, 39.3% of the pre-service teachers were male and 60.7% were female; 29.9% of the participants were 3rd grade, 25.7% were 4th grade, 23.9% were 1st grade and 20.5% were 2nd grade.

Findings Related to the Mean Scores of the "Mathematical Self-Perception" Subdimension and Items

The findings related to the mean scores of pre-service teachers on the "mathematical self-perception" sub-dimension and items of the Self-Efficacy Scale for the Use of Mathematics in Science are given in Table 2.

Table 2. Findings related to the mean scores of mathematical self-perception sub-dimension and items

Expressions	n	$\overline{X}$	ss
5. I do not consider myself sufficient in teaching all kinds of mathematical concepts and rules in science lessons **(I do)***	117	4,11	0,36
6. I believe that I can easily solve mathematical problems in science lessons if I work hard enough	117	4,23	0,49
7. I do not know what to do when I encounter a mathematical problem in science lesson **(I know)***	117	4,36	0,74
9. I do not master the mathematics I use in science teaching as much as my colleagues in the same branch **(I do)***	117	4,17	0,83
11. I do not know (know) how to develop a positive attitude towards mathematics in science lessons	117	3,89	0,64
Mathematical Self-Perception	117	4,15	0,61

While scoring the data within the scope of the research, questions 5, 7, 9 and 11, which contained negative expressions, were reverse coded. When Table 2 is analysed, it can be seen that the pre-service teachers answered the item "I consider myself sufficient in teaching all kinds of mathematical concepts and rules in science lessons" as "most of the time" although it is close to “always”; the item “I believe that I can easily solve mathematical problems in science lessons if I work hard enough” as “always”; “I know what to do when I encounter a mathematical problem in science lessons”; “I know the mathematics I use in science teaching as well as my colleagues in the same branch”; “most of the time”, although close to “always”; and “most of the time” for the item “I do not know how to develop a positive attitude towards mathematics in science lessons”. As a result of the statistical analysis, it was determined that pre-service teachers’ perceptions of the mathematical self sub-dimension were at a high level (X = 4,15).

The findings related to the mean scores of pre-service teachers on the “application of mathematics” sub-dimension and items are given in Table 3.

Table 3. Findings related to the mean scores of the sub-dimension of “application of mathematics” and items

Expressions	**n**	$\overline{X}$	**ss**
12. I think that **I cannot (do not) use mathematics effectively in science lessons***.	117	3,92	0,81
13. I can make students understand the relationships between science and mathematics courses.	117	4,10	0,76
14. I can use mathematical language well while teaching science lessons.	117	3,84	0,65
15. I cannot **(do not) inform students about the importance of mathematics in science lessons***	117	4,03	0,77
16. I believe that I can help students solve their problems related to mathematics	117	4,46	0,89
17. I cannot make logical inferences in science lessons using mathematics **(I can)***.	117	4,28	0,55
Application of Mathematics	117	4,10	0,74

While scoring the data within the scope of the research, questions 12, 15 and 17 containing negative expressions were reverse coded. When Table 3 was analysed, it was found that the pre-service teachers answered “most of the time” for the item “I think that I (use) mathematics effectively in science lessons”; “I can make students comprehend the relationships between science and mathematics lessons. “ item “most of the time” although close to “always”; “I can use mathematical language well while teaching science lessons” item “most of the time”; “I inform students about the importance of mathematics in science lessons” item “most of the time” although close to “always”; “I believe that I can help students solve their problems related to mathematics” item “most of the time”; and “I make logical inferences in science lessons using mathematics” item “most of the time”. As a result of the statistical analysis, it was determined that pre-service teachers’ perceptions of the sub-dimension of the application of mathematics were at a high level (X = 4,10).

The findings related to the mean scores of pre-service teachers on the "mathematical skills" sub-dimension and items are given in Table 4.

Table 4. Findings related to the mean scores of mathematical skills sub-dimension and items

Expressions	**n**	$\overline{X}$	**ss**
1. I think that mathematical concepts are well formed in myself in teaching science	117	4,18	0,52
2. I do not have the necessary mathematical thinking skills to teach the concepts in science lessons effectively **(I do)***	117	4,21	0,81
3. I can increase my success in science lesson with my mathematical skills.	117	3,88	0,67
4. I can gain critical thinking skills, which is one of the aims of science course, with mathematics	117	3,99	0,75
8. I can propose a solution to all kinds of daily life problems with a mathematical approach in science	117	4,35	0,44
10. I believe that I can increase students' problem solving skills in science lessons with mathematics.	117	4,52	0,86
18. I can improve students' problem solving skills with various mathematical games in science lesson.	117	4,11	0,48
Mathematical Skills	117	4,18	0,65

While scoring the data within the scope of the research, the second question containing negative expressions was reverse coded. When Table 4 was analysed, it was found that the pre-service teachers answered "most of the time" for the item "I think that mathematical concepts are well formed in myself in teaching science lesson" although it was close to "always"; "most of the time" for the item "I (have) the necessary mathematical thinking skills to teach the concepts in science lesson effectively"; "most of the time" for the item "I can increase the success in science lesson with my mathematical skills"; "I can gain critical thinking skills, which is one of the aims of science lesson, with mathematics" for the item "most of the time"; "I can propose a solution to all kinds of daily life problems in science lessons with a mathematical approach"; "I believe that I can increase students' problem solving skills in science lessons with mathematics"; and "I can improve students' problem solving skills with various mathematical games in science lessons". As a result of the statistical analysis, it was determined that the pre-service teachers' perceptions of the mathematical self-perception sub-dimension were at a high level (X=4,18).

DISCUSSION AND CONCLUSION

Mathematical concepts and skills have an important place in science education. In order for science teachers to teach these concepts to students effectively, they should have a high self-efficacy perception about using mathematics. In this study, in the light of the studies in the literature, pre-service science teachers' self-efficacy perceptions about using mathematics in the process of teaching science were examined.

The results of the study showed that pre-service science teachers' perceptions of "mathematical self-perception" ($X = 4.15$), "application of mathematics" ($X = 4.10$) and "mathematical skills" ($X = 4.18$) sub-dimensions were at high level. In addition, it was determined that the perception levels of pre-service teachers were respectively for the sub-dimensions of mathematical skills, mathematical self-perception and application of mathematics. The findings obtained are consistent with other studies in the literature. In studies such as Can Taşkın, Günhan Cantürk, and Erdal Öngel (2005), İnce, Gülten, and Kırbaşlar (2012), and Başar (2018), it was determined that the self-efficacy perceptions of pre-service science teachers regarding the use of mathematics were high and the mean scores related to the sub-dimensions of the scale were mathematical skills, application of mathematics, and mathematical self-perception, respectively.

As a result, the high self-efficacy perceptions of pre-service science teachers about using mathematics in science teaching indicate that they have confidence in their knowledge and skills in this subject. This situation shows that pre-service science teachers have the potential to use mathematics effectively in science education and that they are open to improving their competences in this subject.

REFERENCE

Aydoğdu, M. & Tutak, T. (2017). Ortaokul 8. sınıflara yönelik matematiksel modelleme etkinlikleri geliştirme. *Akademik Sosyal Araştırmalar Dergisi*, 5(54), 155-166.

Aydoğdu, M., Cevizci, A.B. & Tutak, T. (2022). Ortaokul öğrencilerinin problem çözme stratejilerini kullanma becerilerine yönelik öğretmen görüşlerinin belirlenmesi. *Journal of Anatolian Education Research (JAER)*, 6, 1-14.

Aydoğdu, M., Erşen, A.N. & Tutak, T. (2014). Materyal destekli matematik öğretiminin ortaokul 6. sınıf öğrenci başarısına ve tutumuna etkisi. *Turkish Journal of Educational Studies*, 1(3), 166-185.

Bağır, M., Karakoyun, G.Ö. & Asiltürk, E. (2022). Views of science teachers on the use of artificial intelligence in education. *International Online Journal of Educational Sciences,* 14, 1223 – 1234.

Basista, B. & Mathews, S. (2002). Integrated science and mathematics professional development programs. *School Science and Mathematics*,102(7), 359-370.

Başar, S. (2018). *Fen Bilimleri Öğretmen Adaylarının Fende Matematiğin Kullanımına Yönelik Özyeterlik İnançları, 21.Yy Becerileri Ve Aralarındaki İlişkinin İncelenmesi*. Yüksek Lisans Tezi, Hacettepe Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Büyüköztürk, Ş., Akgün, Ö.E., Karadeniz, Ş., Demirel, F. & Kılıç Çakmak, E.. (2018). *Bilimsel Araştırma Yöntemleri*. Pegem Akademik Yayıncılık, Ankara.

Çelik, R., Karakoyun, G. Ö., & Asilturk, E. (2022). Evaluation of Middle School 7th Grade Science Skill-Based Questions According to the Revised Bloom Taxonomy. *International Online Journal of Educational Sciences*, 14(3), 705-716.

Deringöl, Y. & Gülten, D.Ç. (2016). Öğretmen adaylarının "fen eğitiminde matematiğin kullanılması" ile ilgili görüşleri: Bir metafor analizi çalışması. *Eğitim ve Öğretim Araştırmaları Dergisi*, 5(1), 43-50.

Flogie, A. & Aberšek, B. (2015). Transdisciplinary approach of science, technology, engineering and mathematics education. *Journal of Baltic Science Education*, 14(6), 779-790.

İç, Ü. & Tutak, T. (2018). Correlation between computer and mathematical literacy levels of 6th grade students. *European Journal of Educational Research*, 7(1), 63-70.

İlhan, A., Tutak, T., İç, Ü. & Ekinci, N. (2020). Matematik öğretmen adaylarının özel öğretim yöntemleri dersine yönelik görüşlerinin incelenmesi. *Elektronik Sosyal Bilimler Dergisi*, 19(73), 156-170.

İnce, E., Gülten Çağırgan, D. & Kırbaşlar, G. (2012). Fen bilgisi öğretmen adaylarının matematik öz-yeterlikleri ve fizik problemlerine yönelik görüşleri, *Hasan Ali Yücel Eğitim Fakültesi Dergisi,* 1, 58-71.

Karakoyun, G. Ö. & Asiltürk, E. (2020a). Fen Bilgisi Öğretmen Adaylarının Akıl Yürütme Süreçlerinde Höristiklerin Rolü: Bileşiklerin Çözünürlüklerine Göre Sıralanması. *Journal Of History School,* 47, 2607-2635.

Karakoyun, G. Ö. & Asiltürk, E. (2020b). Analysis of pre-service science teachers' heuristic reasoning processes about hydrogen bonding. *Journal of Science Learning*, 4, 50-60.

Karakoyun, G. Ö. & Asiltürk, E. (2021). The Role of Heuristics in the Reasoning Process of Pre-Service Science Teachers on the "Chemical Structure–Acidity/Basicity Relationship" Topic. *Acta Chimica Slovenica*, 68(3), 645-657.

Karakoyun, G. Ö. & Asiltürk, E. (2022). The effect of heuristics on the reasoning of the pre-service science teachers on the topic of melting and boiling point. *Acta Chimica Slovenica*, 69, 60-72.

Klaassen, R.G. (2018) Interdisciplinary education: A case study, *European Journal of Engineering Education*, 43(6), 842-859.

Millî Eğitim Bakanlığı (MEB), (2006). İlköğretim fen ve teknoloji dersi (6, 7 ve 8.siniflar) öğretim programı. Ankara. http://ttkb.meb.gov.tr adresinden alındı.

Millî Eğitim Bakanlığı (MEB), (2009). İlköğretim matematik dersi 6-8. sınıflar öğretimprogramı ve kılavuzu. Ankara. http://ttkb.meb.gov.tr adresinden alındı.

Millî Eğitim Bakanlığı (MEB), (2013a). Ortaokul matematik dersi (5, 6, 7 ve 8. siniflar) öğretim programi. Ankara. http://ttkb.meb.gov.tr adresinden alındı.

Millî Eğitim Bakanlığı (MEB), (2013b). İlköğretim kurumlari (ilkokullar ve ortaokullar) fenbilimleri dersi (3, 4, 5, 6, 7 ve 8. siniflar) öğretim programi. Ankara. http://ttkb.meb.gov.tr adresinden alındı.

National Council of Teachers of Mathematics (NCTM), (2000). *Principles and standards of school mathematics*. Reston, VA.

Polat, M., Koç, M. (2024). Dijital ortamlarda fen eğitimi: dijital öğrenme platformları üzerine fen bilgisi öğretmen görüşleri. *Hakkari Review,* 8(1), 32-55.

Taşkın, C., Cantürk, G. & Öngel, E. (2005). Fen bilgisi öğretmen adaylarının fen derslerinde matematiğin kullanımına yönelik özyeterlik inançlarının incelenmesi, *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi,* 17, 47-52.

Tian, M., Wu, X., Li, Y. & Zhou, P. (2008). An analysis of mathematics and science achievements of American youth with nonparametric quantile regression. *Journal of Data Science*, 6, 449-465.

DETERMINATION OF CHEMISTRY LEARNING MOTIVATIONS OF PROSPECTIVE SCIENCE TEACHERS: A SCALE DEVELOPMENT STUDY

Erol Asiltürk[1]

SUMMARY

The aim of this study is to adapt the "Science Motivation Questionnaire-2" scale developed by Glynn et al. (2011) and adapted into Turkish by Işın (2019) to chemistry education and to examine the validity and reliability of this adapted scale. In the study, "Chemistry Learning Motivation Scale" (CLMS) was developed by following the scale adaptation steps. The scale, which was applied to 30 pre-service science teachers in the pilot application, was finally applied to 152 pre-service science teachers. Exploratory factor analysis, confirmatory factor analysis and Cronbach Alpha coefficient were used to analyse the data. The results of the analyses showed that the PSTS consisted of 22 items and 5 sub-factors (intrinsic motivation, career motivation, self-determination, self-efficacy, self-efficacy, grade motivation). The total variance explained by the scale was 63.14% and Cronbach Alpha coefficient was 0.79. The findings obtained show that the CCCS is a valid and reliable scale that can be used to determine the level and types of chemistry motivation of pre-service science teachers.

Keywords: Chemistry Learning Motivation, Pre-service Science Teachers, Validity, Reliability, Scale Development

INTRODUCTION

Education is defined as a set of interactions that lead to permanent changes in an individual's behaviour and its main purpose is to prepare him/her for life (Ertürk, 2013). In this context, it is clearly seen that education permeates every aspect of life and is one of the basic building blocks of society. It fulfils

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critically important functions such as transferring cultural heritage to the next generations, raising qualified manpower to contribute to development, building tolerant and conscious citizens, and enabling individuals to reach their full potential (Erdem, 1998). Especially science education plays a key role in the development and progress of countries (Ayas, 1994). Science education encourages individuals to be innovative and productive by developing scientific thinking, problem solving, critical analysis and research skills. In this way, it becomes possible for societies to make progress in scientific and technological fields and to stand out in global competition. Chemistry is one of the oldest and most effective fields among science disciplines, playing a pioneering role in the development of science and the facilitation of daily life (Turgut et al., 1997).

Although it is not possible to determine the exact origins of chemistry education, it is known that it started to gain importance in the 18th century with the acceptance of modern chemistry. In Turkey, modern chemistry and chemistry education gained a place in the 19th century, during the Ottoman Empire. Although chemistry knowledge was transferred through master-apprentice relationship in the early stages, the increasing need for education over time necessitated the transition from individual education to collective education. This transition has brought along some problems. Researches reveal the existence of many problems in chemistry education such as teaching methods, teacher inadequacy, inadequate application environment and lack of tools and equipment (Dölen, 2013). Especially crowded classes, inadequacy of individual applications and inadequate training of prospective teachers are among these problems. One of the frequently studied topics in chemistry education is the examination of students' reasoning. For this reason, there are many studies in the literature examining students' reasoning, especially their heuristic reasoning, known as mental shortcuts. (Karakoyun & Asiltürk, 2020a; Karakoyun & Asiltürk, 2020b; Karakoyun & Asiltürk, 2021; Karakoyun & Asiltürk, 2022).. The development of chemistry education in Turkey started in the 1990s and an increase in chemistry education research has been observed after the 2000s (Sözbilir, Kutu, & Yaşar, 2012). Whether it is chemistry education or other disciplines, educating students with analytical and higher-level thinking skills has become one of the important goals of education (Çelik et al., 2022; Bağır et al., 2022). An important part of these researches emphasise the importance of attitude and motivation in chemistry education. Educational researchers have conducted studies showing that students' attitudes towards a subject have a positive effect on their academic achievement (Güvercin, Tekkaya, & Sungur, 2010).

Motivation can be defined as a set of motives that mobilise individuals to achieve a certain goal and enable them to make efforts to achieve this goal

(Demirtaş, 2005; Ertürk, 2017). Since it is a subjective phenomenon, the factors that trigger motivation differ from person to person (Koçel, 2010). The concepts of learning and motivation cannot be separated from each other. Motivation facilitates learning by directly affecting cognitive processes (Schunk et al., 2013). Many studies on the effect of motivation on chemistry learning show that motivation positively affects learning (Akpur, 2017). Studies have revealed that motivated students learn chemistry concepts more easily and retain these concepts more permanently (Güvercin et al., 2010). In a study conducted by Zusho (2003), it was observed that the motivation of 458 students taking introductory university chemistry course had a positive effect on learning chemistry. Eymur and Geban (2011) examined the relationship between motivation and academic achievement of chemistry teacher candidates. In the study, it was stated that extrinsic motivation had a negative relationship with achievement and intrinsic motivation had a positive relationship with achievement. Yıldıran Sönmez (2015) examined the effect of 11th grade students' understanding of acid and base concepts and their motivation to learn chemistry with case-based learning method. As a result of the research, it was observed that the chemistry achievement of students whose motivation increased also increased. It has been determined in the studies in the literature that the level of motivation positively affects the achievement and attitudes in mathematics (İlhan et al., 2020; Aydoğdu et al., 2014; İç & Tutak, 2018) and science (Halimoğlu, 2019; Bayrak, 2023) as well as chemistry learning.

In addition to motivation studies related to chemistry, there are also many studies examining the relationship between motivation and attitude towards chemistry. In these studies, it has been observed that chemistry motivation increases in direct proportion with attitude or both phenomena can change positively and this increase positively affects academic achievement. Tarkın (2014) conducted a study on 11th grade students and concluded that the case-based teaching method had a positive effect on both motivation and attitude and that there was a significant difference between these two and the level of concept understanding. Kara (2018) observed that the positive effect of using the 5E model interactive notebook on attitude and motivation while teaching the mixtures unit of chemistry course increased academic achievement. Kuşdemir, Ay, and Tüysüz (2013) investigated the effect of problem-based learning method on the subject of mixtures in chemistry course and observed that students' attitude, motivation and academic achievement in chemistry course increased positively. Similarly, Ulusoy (2013) revealed in his study that the context (life) based teaching method used in the 10th grade chemistry course on halogens had a positive effect on students' chemistry attitudes and chemistry motivation and increased their achievement.

Motivation Concept

In educational institutions, it has been a subject of curiosity for years that some students easily grasp the lessons and achieve high success, while others are in danger of failing. This situation raises important questions such as "Why do some students work hard while others do not?" and "What constitutes the basis of academic success?". Various studies have been conducted by researchers to find answers to these questions and different explanations have been offered. Although each of them is important, it is obvious that "motivation" is one of the most comprehensive and convincing answers to these questions (Zusho, Pintrich & Coppola, 2003).

Motivation derives from the Latin word "movere" meaning "to mobilise, to activate" (Steers & Porter, 1975). In this context, being motivated can be defined as the state of being encouraged and mobilised to do a job. An individual who lacks inspiration, power or a mobilising factor is considered to be unmotivated. Motivation, which is one of the basic subjects of psychology, is an important factor that encourages production and provides progressive power. Individuals from all segments of society can be motivated to act by intrinsic or extrinsic factors. For example, a sense of curiosity and interest may motivate one student, while another student may be motivated by the desire to gain approval from teachers or parents. While the sense of achievement is a driving force for some students, the desire to acquire new skills can motivate others (Deci & Ryan, 2000).

Motivation is considered one of the most fundamental and complex concepts of psychology. Motivation, which is defined in different ways by different researchers, generally includes internal or external factors that encourage and mobilise to do a job. In this context, the role and importance of motivation in the fields of education and learning is quite high. Watters and Ginns (2000) define motivation as a complex psychological structure that tries to explain the effort and behaviour in different activities. Brophy (1998) considers motivation as a concept used to explain the initiation, direction, intensity and determination of goal-oriented behaviour. Öncül (2000) defines motivation as "motivation" and explains motivation as a state of tension that leads to behaviour, sustains it and directs it towards a goal. Motivation is defined as the ability to make students or others work in the desired way, the ability to make them work in the desired action with love and enthusiasm.

Wolters and Rosenthal's (2000) research showed that highly motivated students tend to make more effort and achieve more success than low motivated students. This suggests that motivation increases students' active participation and their determination to complete tasks in the classroom. Stipek (1988) reached similar findings and found that highly motivated students acquire more knowledge, feel better about themselves and are more likely to continue their education. Öncü's (2004) study showed that there is a direct relationship between motivation and achievement and that an increase in motivation level creates a more positive school environment for both teachers and students. Highly motivated students show more interest in lessons and this situation also lightens the workload of teachers. Motivation affects not only the acquisition of new knowledge but also the performance of previously learned skills, strategies and behaviours. For example, a motivated student can perform a previously learnt song more effectively, while a student with low motivation may have difficulty in performing the same skill. Barlia (1999) argues that motivation also affects the frequency and duration of learning activities. In subjects that arouse curiosity, students can concentrate their attention for a longer period of time and continue to actively acquire knowledge.

Relationship between Motivation and Learning

Learning motivation, which is one of the cornerstones of individual success in the education process, means that individuals find the materials to be learnt meaningful and valuable and foresee that they can benefit from these materials in the future. This motivation encourages individuals to learn actively and increases their desire and effort to study. On the contrary, lack of motivation leads to an anti-learning attitude and reluctance and negatively affects the academic progress of individuals. As stated by Akbaba (2006), students who lack motivation avoid studying and spend their time on extracurricular activities. This situation may lead to academic failure and feelings of inadequacy and damage individuals' self-confidence. On the other hand, highly motivated students actively participate in learning, overcome difficulties and acquire deeper knowledge.

Intrinsic factors affecting an individual's motivation to learn include curiosity, interests, attitudes towards success, attention level and personality traits. While curiosity encourages individuals to discover and learn new information, interests make learning more enjoyable. Attitude towards success increases the individual's determination to overcome difficulties and reach the goal. Attention level ensures that learning is concentrated and focussed. Personality traits can also affect motivation. For example, extroverted and sociable individuals may be more open to new experiences and more willing to learn. Extrinsic factors include factors arising from the learning environment and experiences of the individual. Fatigue, illness, negative attitude towards the lesson or activity and extracurricular thoughts can be given as examples of these factors. Factors such as classroom environment, teacher-student relationship, parents' relationship with their children and socioeconomic status are also among the important extrinsic factors affecting motivation. Student motivation is not only affected by internal and external factors. Attitudes and beliefs about school and learning environment also play an important role. The student's belief that he/she can achieve a task, the value he/she places on the learning material and his/her feelings towards learning are factors that directly affect motivation. Another important factor affecting motivation in the classroom environment is the level of meaning of the subject. If the subject matter is too high or too low for the students' level of knowledge, students may start to move away from the subject matter. In addition, if students do not know exactly what to do during a classroom activity, their motivation levels may decrease and their concentration may deteriorate.

Akbaba (2006) identified a number of factors that affect student motivation. Some of these factors are as follows:

- Stress and Pressure: Students under excessive pressure may experience stress and depression. This can lead to apathy towards learning and lack of motivation.
- Appropriateness Level: It is important that homework assignments are appropriate for the age and skill level of the student. Assignments that are too easy can bore students, while assignments that are too difficult can make students give up.
- Meaning and Interest: Assignments should be on topics that the student finds interesting and meaningful. This makes learning more enjoyable and increases motivation.
- Autonomy and Control: Teachers and parents should give students freedom instead of trying to control everything. This helps students develop the ability to take responsibility and manage their own learning.
- Clear Instructions: The instructions and rules in homework should be clear and understandable. This ensures that students clearly understand what they need to do and avoid mistakes.
- Recognising Achievement: Students should be rewarded when they make progress. These rewards can be financial, verbal recognition or special privileges.
- Supportive Environment: The family and friend environment around the student should be supportive. This gives the student a sense of confidence and increases their motivation.

METHOD

Research Model

This study aims to examine the validity and reliability of the research chemistry learning motivation scale (RLCS) on pre-service science teachers and to determine the types of students' motivation towards learning chemistry using this scale. In this study, which is a descriptive research type, the survey model was used. Survey model is a method for examining the characteristics of entities, objects, groups, institutions and various fields. Descriptive research usually takes place in natural environments and it is not possible to control variables experimentally or physically. The issues addressed in such studies continue to exist even if these studies are not conducted (Büyüköztürk, 2018).

Study Group

The study group of the research consists of a total of 152 science teachers studying in the 1st, 2nd, 3rd and 4th grades of Fırat University in the 2023-2024 academic year and who voluntarily participated in the research.

Data Collection Tools

In science teaching programmes, it is very important to determine the motivation levels and types of pre-service teachers towards learning chemistry in order to provide an effective chemistry education. For this purpose, the "Science Motivation Questionnaire 2" scale developed by Glynn et al. (2011) and adapted into Turkish by Işın (2019) was re-adapted for pre-service chemistry teachers in this study and a content validity study was conducted. In the study, the original scale consisting of 25 items and 5 sub-factors (Intrinsic Motivation, Self Determination, Self Efficacy, Career Motivation and Grade Motivation) was reorganised in a way that pre-service chemistry teachers could understand. The adapted scale was examined by 3 experienced science and chemistry experts and necessary adjustments were made.

The adapted scale was applied to 152 pre-service chemistry teachers studying in the 1st, 2nd, 3rd and 4th grades of the Department of Science Teaching at Fırat University in the 2023-2024 academic year. In the analysis of the data, internal consistency analysis and factor analysis were used for content validity study. As a result of the analyses, it was determined that the scale maintained its 5-factor structure and each sub-factor showed high internal consistency.

Information about the sub-dimensions of the motivation to learn chemistry scale is as follows (Glynn et al., 2011):

- Intrinsic motivation is related to the student's sense of pleasure and satisfaction from learning science. Students with this type of motivation learn science with a sense of curiosity, a desire to acquire knowledge, and a desire to develop problem-solving skills. Science projects and experiments provide an enjoyable and satisfying learning experience for intrinsically motivated students.
- Self-determination refers to the student's effort to learn science and the belief system behind this effort. Students with high self-determination

are willing to overcome the difficulties of science learning and believe that they can achieve success in science subjects. This belief enables students to devote time to science learning and not to give up in the face of difficulties.

- Self-efficacy is a student's belief in his/her ability to understand science topics and develop science skills. Students with high self-efficacy feel competent in science learning and this increases their learning motivation and success.
- Career motivation is the student's view of science learning as a tool for his/her future career. Students with this type of motivation believe that being successful in science will provide them with better job opportunities and career development.

In the study, a personal information form was also applied to the pre-service teachers to determine their demographic characteristics such as gender, age, grade level, grade point average of the previous semester chemistry course.

Data Collection

The data of this study were obtained from 152 participants selected by random sampling method from among the prospective science teachers studying in the second semester of the 2023-2024 academic year at the Department of Science Teaching, Faculty of Education, Fırat University. "Chemistry Learning Motivation Scale" was used as a data collection tool. In order to avoid any problems in the actual application of the scale and to determine the application period and conditions, a pre-application was made to 30 students studying in the first year. In the light of the findings obtained in the pre-application, the time and conditions to be used in the main application were optimised. After the pre-application, the main application was carried out in the second semester of 2023-2024 during the participants' class hours. Before the application, the purpose of the scale, the way of filling it out, the fact that it does not carry any grade value and that participation is voluntary were explained in each class. During the implementation, questions from the participants were answered and each class lasted approximately 20 minutes.

Analysing the Data

In this study, the data obtained were analysed using SPSS 22.0 and AMOS programmes. Construct validity is an indicator of how well the sub-dimensions of a scale and the relationship between these dimensions and the overall scale are measured (Tanrıöğren, 2012). In this context, Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) methods were used to test the construct validity of the scale used in the study. Factor analyses are statistical methods used to determine the latent structure of a large number of variables that are thought to be related and to test the accuracy of this structure (Altunışık et al., 2007). In this context, in order to examine the construct validity of the Chemistry Learning Motivation Scale, firstly, Exploratory Factor Analysis (EFA) was applied through SPSS 22.0 programme and the number of factors of the scale was determined. Then, Confirmatory Factor Analysis (CFA) was performed using Lisrel 8.71 software to confirm the accuracy of the obtained structural model. Confirmatory factor analysis is a method in which the suitability of a pre-constructed and restricted model to the data is tested and it is considered as an advanced technique used in testing theories related to latent variables (Tabachnik & Fidell, 2007). Finally, internal consistency analysis was performed to determine the reliability level of the Motivation in Science Education Scale and Cronbach's alpha coefficient was calculated using SPSS 22.0 programme.

FINDINGS

Construct Validity of Chemistry Learning Motivation Scale: Exploratory and Confirmatory Factor Analyses

A two-stage process was followed to evaluate the construct validity of the scale. In the first stage, Exploratory Factor Analysis (EFA) was applied using SPSS 22.0 programme. In this analysis, it was aimed to determine the sub-dimensions of the scale and the relationships of these dimensions with the overall scale. In the second stage, Confirmatory Factor Analysis (CFA) was conducted using AMOS software. With CFA, the factor structure obtained in AFAwas tested for its suitability to the data and necessary steps were taken to improve the model.

Findings Related to Exploratory Factor Analysis

Before starting the factor analysis, it was checked whether the sample used for the analysis was of sufficient size and whether the data showed normal distribution. For this purpose, Kaiser-Meyer-Olkin (KMO) and Bartlett's tests were applied. The results obtained are presented in Table 1.

Table 1. KMO and Bartlett's test findings

KMO Analysis	0,847
Bartlett's Test	3163,176 Degrees of freedom 139 Significance .000

In this study, Kaiser-Meyer-Olkin (KMO) sampling adequacy test was used to assess the suitability of the data set for Exploratory Factor Analysis (EFA). The KMO test results showed that the sample size was "very good" for AFAwith a high value of 0.847 (> 0.80). This finding is consistent with the studies by Tavşancıl (2014) and Bilir (2018), in which a KMO value of

≥ 0.80 was interpreted as "very good". Bartlett's test of sphericity was used to examine whether the data set was normally distributed. The Bartlett value obtained was found to be statistically significant ($p < 0.05$). This indicates that the data set is suitable for AFAand that the hypothesis of normal distribution is accepted.

Table 2. AFA Factor Loadings

Items	Factors				
	1	2	3	4	5
Item 10	,761				
Item 13	,684				
Item 7	,712				
Item 23	,608				
Item 25	,717				
Item 12	,639				
Item 9		,636			
Item 18		,711			
Item 14		,695			
Item 16		,643			
Item 21		,613			
Item 15		,628			
Item 4			,725		
Item 24			,599		
Item 8			,647		
Item 2			,709		
Item 20			,733		
Item 22				,714	
Item 11				,655	
Item 5				,691	
Item 19				,712	
Item 6				,559	
Item 3					,681
Item 17					,707
Item 1					,624
Eigenvalues	4,725	2,351	2,094	1,744	1,471
Variance Explained	%23,418	%13,204	%9,317	%8,256	%6,941
Total variance	%61,136				

AFArevealed a five-factor structure. These factors have the capacity to explain 61.136% of the total variance. Each factor represents sub-dimensions related to the set of variables and is open to a unique interpretation. The first factor consists of five items with the highest loadings with factor loadings ranging from .608 to .761. This factor with an eigenvalue of 4.725 explains 23.418% of the total variance. Interestingly, all items loading on the first factor were also placed in their own sub-factors in the original scale. This shows that the factor has a strong sub-dimensional representation and supports the construct validity of the scale. The eigenvalue of the second factor, in which five items loaded with factor loadings ranging from .613 to .711, was 2.351 and explained 13.204% of the variance. The fact that all items loaded on this factor also loaded on its own factor shows that the factor represents a unique sub-dimension. The third factor consists of five items with factor loadings ranging between .599 and .733. The eigenvalue of the factor is 2.094 and explains 9.317% of the total variance. The fact that all items loaded on the third factor were placed in their own sub-factor in the original scale supports the structural validity of this factor. The eigenvalue of the fourth factor, in which four items loaded with factor loadings ranging from .559 to .714, was 1.744 and explained 8.256% of the total variance of the scale. The fact that all items loaded on this factor loaded on its own factor shows that the factor represents a unique sub-dimension. Finally, three items loaded on the fifth factor. The factor loadings of these items are between .624 and .707. The eigenvalue of the factor explaining 6.941% of the total variance is 1.471. All items under this factor loaded only on their own sub-factors. This indicates that the factor may have a weaker sub-dimension representation or a clearer structure may emerge with more data collection. AFAresults show that there is a five-factor structure and these factors represent the sub-dimensions of the scale. The high factor loadings and the fact that each factor represents a unique sub-dimension support the structural validity of the scale. The fact that the fifth factor has a weaker structure is a situation that should be taken into consideration in future studies. Table 3 presents in detail to which sub-dimension each item belongs. This table clearly shows the sub-dimensions used by the researchers in their analyses and the items assigned to them.

Table 3. Sub-dimensions of Chemistry Learning Motivation Scale (LLMS)

Intrinsic Motivation	Career Motivation	Self-Determination	Self-Efficacy	Grade Motivation
Item 1	Item 7	Item 5	Item 9	Item 2
Item 3	Item 10	Item 6	Item 14	Item 4
Item 17	Item 12	Item 11	Item 15	Item 8
	Item 13	Item 19	Item 16	Item 20
	Item 23	Item 22	Item 18	Item 24
	Item25		Item 21	

Findings Related to Confirmatory Factor Analysis

Chemistry Learning Motivation Scale (LMSS) has 5 sub-factors and 25 items within the latent structure determined by exploratory factor analysis. Confirmatory factor analysis was performed to verify this latent structure and to determine the fit index values. A path (PATH) map file was created based on the analysis results obtained using SPSS AMOS programme. Table 4 shows the path map of the numerical data related to the t value obtained as a result of confirmatory factor analysis.

Table 4. Findings related to CFA item loadings

Item	Factors				
	Intrinsic Motivation	**Career Motivation**	**Self-Determination**	**Self-Efficacy**	**Grade Motivation**
Item 10	,65				
Item 13	,70				
Item 7	,61				
Item 23	,72				
Item 25	,66				
Item 12	,71				
Item 9		,77			
Item 18		,75			
Item 14		,69			
Item 16		,61			
Item 21		,64			
Item 15		,59			
Item 4			,52		
Item 24			,61		
Item 8			,74		
Item 2			,48		
Item 20			,65		
Item 22				,46	
Item 11				,62	
Item 5				,59	
Item 19				,52	
Item 6				,44	
Item 3					,73
Madde17					,67
Item 1					,61

The item loadings of the Evaluation Form (EFA) presented in Table 4 show a range between 0.39 and 0.75. This range is compatible with the item loadings of the Chemistry Learning Motivation Scale (CLMS) above 0.30 and shows that the item loadings obtained by CFA are significant.

In the study, the values of various indices used to evaluate the fit of the Confirmatory Factor Analysis (CFA) model were analysed by comparing them with the Confirmatory Factor Analysis Model Fit Index Values table presented by Seçer (2015). The findings obtained are given in Table 5.

Tablo 5. DFA model fit indices

Fit index	Acceptable fit	Excellent fit	Result of the analysis	Fit results
NFI	.90≤NFI≤.95	.95≤NFI≤1	.91	Acceptable
NNFI	.90≤NNFI≤.95	.95≤NNFI≤1	.94	Acceptable
IFI	.90≤IFI≤.95	.95≤IFI≤1	.92	Acceptable
RFI	.90≤RFI≤.95	.95≤RFI≤1	.93	Acceptable
CFI	.90≤CFI≤.95	.95≤CFI≤1	.92	Acceptable
GFI	.90≤GFI≤.95	.95≤GFI≤1	.91	Acceptable
AGFI	.85≤AGFI≤.90	.90≤AGFI≤1	.95	Excellent
RMR	.05≤RMR≤1.0	.00≤RMR≤.05	.074	Acceptable
RMSEA	.05≤RMSEA≤.08	.00≤RMSEA≤.05	.066	Acceptable
X^2/sd	2-3	0-2	2,69	Acceptable

The fit indices presented in Table 5 were analysed to evaluate the psychometric properties of the developed scale. As a result of the fit analyses, it was observed that the Normed Fit Index (NFI), Tucker-Lewis Index (RFI), Goodness of Fit Index (GFI) and Root Mean Square Residual (RMR) values met the acceptable fit criteria (.90 or above). In addition, Normed Non-Fit Index (NNFI), Incremental Fit Index (IFI), Comparative Fit Index (CFI) and Adjusted Goodness of Fit Index (AGFI) values were found to meet the excellent fit criteria (.95 or above). Finally, the Root Mean Square Error of Approximation (RMSEA) value was less than 0.05, indicating that the model fit the data quite well. With the item fit indices meeting the desired criteria, the Indirect Factor Analysis (EFA) was completed and in the next step, internal consistency analysis was performed to test the reliability of the scale.

Findings Related to the Reliability Analysis of Chemistry Learning Motivation Scale (CLMS)

In this study, Alpha (Cronbach Alpha) coefficient model was used to evaluate the reliability of the scale. As a result of the analyses, the internal consistency coefficient of the scale was determined as α=.791. This value shows that the scale is a reliable measurement tool. According to the generally accepted criteria, Cronbach Alpha coefficient higher than 0.70 indicates that the scale is reliable.

CONCLUSION

Within the scope of this research, "Chemistry Learning Motivation Scale" (CLMS) was developed based on "Motivation Scale in Science Education" and "Science Motivation Questionnaire-2 (SMQ-2)" and the validity and reliability studies of the developed scale were carried out in three stages:

- A pilot study was conducted with 30 pre-service science teachers.
- Three chemistry experts gave their opinions about the content and format of the scale.

- After the pilot application, the scale was revised and finalised.

Data were collected from a total of 152 pre-service science teachers studying at the 1st, 2nd, 3rd and 4th grades of Fırat University. The construct validity of the scale was examined by Analytic Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) methods. Kaiser-Meyer-Olkin (KMO) sampling adequacy coefficient was calculated as 0.47 and this value indicates a "very good" sample size. As a result of the normality distribution tests of the data, it was determined that the sample showed a normal distribution.

In this study, the Personality Trait Scale (PTS) [Add Source] was adapted into Turkish and its psychometric properties were analysed. In the first stage of the study, the factor structure of the scale was investigated using Exploratory Factor Analysis (EFA) method. The findings showed that the scale reached a 5-factor structure as a result of EFA and explained 61.136% of the total variance. According to Büyüköztürk (2013), it is desirable that the total variance value is greater than 30%. Therefore, it was seen that the variance value obtained was high enough in the scale adaptation process and reflected the factor structure of the original scale. Then, Confirmatory Factor Analysis (CFA) was used to confirm the accuracy of the structure consisting of 25 items and 5 sub-factors. In the analysis, t values, factor loading values and model fit index values were examined. It was determined that the factor loading values were statistically significant and each item contributed sufficiently to the factor to which it belonged. CFA fit index values also showed that the Turkish version of the scale had a good fit. While NFI (Normed Fit Index), RFI (Relative Fit Index), GFI (Goodness of Fit Index), RMR (Root Mean Square Reesidual) and X2/sd values were within acceptable fit limits, NNFI (Non-Normed Fit Index), IFI (Incremental Fit Index), CFI (Comparative Fit Index), AGFI (Adjusted Goodness of Fit Index) and RMSEA (Root Mean Square Error of Aproximation) values met the criteria of excellent fit. In the light of these findings, it can be said that the Turkish version of the PBSS scale is a reliable and valid measurement tool. The scale can be used to assess the personality traits of Turkish-speaking individuals.

Exploratory Factor Analysis (AFA) and Confirmatory Factor Analysis (DFA) revealed that the scale has a 5-factor structure and the Turkish version is compatible with the original scale. In the light of these findings, the scale was considered to be a valid measurement tool. In the next stage of the study, the reliability level of the scale was analysed using Cronbach Alpha coefficient. According to the findings, the internal consistency coefficient of the whole scale was determined as α=.791. This value is a high reliability indicator according to Nunnally and Bernstein (1994). Therefore, it is concluded that the Turkish version of the scale is a reliable measurement tool.

REFERENCES

Akbaba, S. (2006). Eğitimde motivasyon. *Kazım Karabekir Eğitim Fakültesi Dergisi*, 13, 343-361.

Akpur, U. (2017). Predictive and explanatory relationship model between procrastination, motivation, anxiety and academic achievement. *Eurasian Journal of Educational Research,* 17(69), 221-21.

Altunışık, R., Coşkun, R., Bayraktaroğlu, S. ve Yıldırım, E. (2007). *Sosyal Bilimlerde Araştırma Yöntemleri SPSS Uygulamaları*. Sakarya Yayıncılık, İstanbul.

Ayas, A. (1994). Doğukaradeniz Bölgesindeki Liselerde Kimya Eğitiminin Durumu ve Öğrencilerde Bazı Temel Kavramların Gelişimi. *ÇÜ Eğitim Fakültesi, I. Eğitim Bilimleri Kongresi Bildirileri Kitabı*, 3, 913-919.

Aydoğdu, M., Erşen, A. N., ve Tutak, T. (2014). Materyal destekli matematik öğretiminin ortaokul 6. sınıf öğrenci başarısına ve tutumuna etkisi. *Turkish Journal of Educational Studies*, 1(3), 166-185.

Bağır, M., Karakoyun, G.Ö. & Asiltürk, E. (2022). Views of science teachers on the use of artificial intelligence in education. *International Online Journal of Educational Sciences,* 14, 1223 – 1234.

Barlia, L. (1999). *High School Students' Motivation to Engage in Conceptual Change Learning in Science*, Doktora Tezi, The Ohio State University, Ohio.

Bayrak, F. (2023). *Fen Bilimleri Dersi Eğitiminin Oyunlaştırılmış E-Öğrenme Ortamlarıyla Desteklenmesinin Motivasyon ve Başarıya Etkisi*. *Yüksek Lisans Tezi*, Hacettepe Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Brophy, J. (1998). *Motıvatıng Students To Learn*. New York: McGraw-Hill.

Büyüköztürk, Ş., Akgün, Ö.E., Karadeniz, Ş., Demirel, F. ve Kılıç Çakmak, E.. (2018). *Bilimsel Araştırma Yöntemleri*. Pegem Akademik Yayıncılık, Ankara.

Çelik, R., Karakoyun, G. Ö., & Asilturk, E. (2022). Evaluation of Middle School 7th Grade Science Skill-Based Questions According to the Revised Bloom Taxonomy. *International Online Journal of Educational Sciences*, 14(3), 705-716.

Deci, E. L. ve Ryan, R. M. (2000). The "what" and "why" of goal pursuits: human needs and the Self-Determination of behaviour. *Psychological Inquiry*, 4, 227-268.

Demirtaş, S. (2005). *Çalışma Yaşamında Motivasyonun Önemi ve Teşvik Araçlarının Yeri,* Yüksek Lisans Tezi, Marmara Üniversitesi Sosyal Bilimler Enstitüsü, İstanbul.

Dölen, E. (2013). Modern Kimyanın Doğuşu ve Türkiye'ye Girişi. Mustafa Sözbilir (Ed.), *Türkiye'de Kimya Eğitimi* (1. Baskı) içinde (s. 21-65) İstanbul: Türkiye Kimya Derneği.

Erdem, A. R. (1998). Süreç kuramlarının eğitim yönetimine katkıları. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi,* 4(4), 51-57.

Ertürk, M. (2017). *İşletme Biliminin Temel İlkeleri*. İstanbul: Beta Basım Yayım.

Ertürk, S. (2013). *Eğitimde Program Geliştirme* (6. baskı). Ankara: Edge Akademi Yayınları

Eymur, G. ve Geban, Ö. (2011). An investigation of relationship between motivation and academic achievement of pre-service chemistry teachers. *Egitim ve Bilim,* 36(161), 246.

Glynn, S. M., Taasoobshirazi, G. ve Brickman, P. (2009). Science motivation questionnaire: Construct validation with nonscience majors. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching,* 46(2), 127-146.

Glynn, S.M., Brickman, P., Armstrong N. ve Taasoobshirazi, G. (2011). Science Motivation Questionnaire II: Validation with science majors and nonscience majors. *Journal of Research in Science Teaching*. 48(10), 1159-1176.

Güvercin, Ö., Tekkaya, C. ve Sungur, S. (2010). A cross age study of elementary students' motivation towards science learning. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi,* 39(39), 233-243.

Güvercin, Ö., Tekkaya, C. ve Sungur, S. (2010). A cross age study of elementary students' motivation towards science learning. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi,* 39(39), 233-243.

Halimoğlu, G. (2019). *Ortaokul Öğrencilerinin Fen Bilimlerine Karşı Merak, Motivasyon ve Fen Okuryazarlık Düzeylerine Etki Eden Faktörlerin İncelenmesi*. Yüksek Lisans Tezi, İstanbul Üniversitesi-Cerrahpaşa, Lisansüstü Eğitim Enstitüsü, İstanbul.

Işın, O. (2019). *Fen Eğitiminde Motivasyon Ölçeği: Geçerlik ve Güvenirlik Çalışması*. Yüksek Lisans Tezi, Yıldız Teknik Üniversitesi Fen Bilimleri Enstitüsü, İstanbul.

İç, Ü. ve Tutak, T. (2018). Correlation between computer and mathematical literacy levels of 6th grade students. *European Journal of Educational Research,* 7(1), 63-70.

İlhan, A., Tutak, T., İç, Ü. ve Ekinci, N. (2020). Matematik Öğretmen Adaylarının Özel Öğretim Yöntemleri Dersine Yönelik Görüşlerinin İncelenmesi. *Elektronik Sosyal Bilimler Dergisi,* 19(73), 156-170.

Kara, H. (2018). *5E modeli destekli etkileşimli defterin öğrencilerin karışımlar konusundaki başarısına, motivasyon ve tutuma etkisi*. Doktora Tezi, Hacettepe Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Karakoyun, G. Ö., & Asiltürk, E. (2020a). Fen Bilgisi Öğretmen Adaylarının Akıl Yürütme Süreçlerinde Höristiklerin Rolü: Bileşiklerin Çözünürlüklerine Göre Sıralanması. *Journal Of History School*, 47, 2607-2635.

Karakoyun, G. Ö., & Asiltürk, E. (2020b). Analysis of pre-service science teachers' heuristic reasoning processes about hydrogen bonding. *Journal of Science Learning*, 4, 50-60.

Karakoyun, G. Ö., & Asiltürk, E. (2021). The Role of Heuristics in the Reasoning Process of Pre-Service Science Teachers on the "Chemical Structure–Acidity/Basicity Relationship" Topic. *Acta Chimica Slovenica*, 68(3), 645-657.

Karakoyun, G. Ö., & Asiltürk, E. (2022). The effect of heuristics on the reasoning of the pre-service science teachers on the topic of melting and boiling point. *Acta Chimica Slovenica*, 69, 60-72.

Koçel, T. (2010). *İşletme Yöneticiliği*. İstanbul: Beta Yayınevi.

Kuşdemir, M., Ay, Y. ve Tüysüz, C. (2013). An analysis of the effect of problem based learning model on the 10th grade students' achievement, attitude and motivation in the unit of "Mixtures". 7(2), 195-224.

Nunnally, J.C. ve Bernstein, I.H. (1994) The Assessment of Reliability. *Psychometric Theory,* 3, 248-292.

Öncü, H. (2004). *Motivasyon ve Sınıf Yönetimi*. Ankara: Nobel Yayınevi.

Schunk, D. H., Meece, J. R. ve Pintrich, P. R., (2013). *Motivation in Education: Theory, Research, and Applications*. Edinburgh: Pearson Education Limited.

Seçer, İ. (2015). *SPSS ve Lisrel ile Pratik Veri Analizi*. Ankara: Anı Yayıncılık.

Steers, M. R. ve Porter, L. W. (1975). *Motivation and Work Bahaviour*. NY: McGraw-Hill.

Stipek, D. (1988). *Motivation to Learn: From Theory to Practice.* Englewood Cliffs, NJ: Prentice Hall.

Tabachnick, B. G. ve Fidell, L. S. (2007). *Using Multivariate Statistics* (5th ed.). New York: Allyn and Bacon.

Tanrıöğen, A. (2012). *Bilimsel Araştırma Yöntemleri*. 2. Baskı, Ankara: Anı Yayıncılık.

Tarkın, A. (2014). Implementation of case-based instruction on electrochemistry at the 11th grade level. *Chemistry Education Research and Practice*, 18, 659-681.

Turgut, M. F., Baker, D., Cunningham, R. ve Piburn, M. (1997). İlköğretim fen öğretimi. Ankara: *YÖK/Dünya Bankası Milli Eğitimi Geliştirme Projesi Hizmet Öncesi Öğretmen Eğitimi*.

Ulusoy, F. M. (2013). *Bağlam Temelli Öğrenme ile Desteklenen Bütünleştirici Öğrenme Modelinin Öğrencilerin Kimya Öğretimine Yönelik Tutum, Motivasyon ve Başarılarına Etkisi*. Yüksek Lisans Tezi, Hacettepe Üniversitesi, Fen Bilimleri Enstitüsü, Ankara.

Watters, J. J. ve Ginns, I. S. (2000). Developing motivation to teach elemantary science: effect of collaborative and authentic learning practices in preservice education. Journal of Science Teacher Education. 11(4), 277-313.

Wolters, C.A., ve Rosenthal, H. (2000). The relation between students' motivational beliefs and their use of motivational regulation strategies. *International Journal of Educational Research*. 33,801-820.

Yıldıran Sönmez, D. (2015). The Effect of case based learning instruction on 11th grade students' understanding of acids and bases concepts and their motivation to learn chemistry. Doctoral Thesis, Middle East Technical University, Secondary Science and Mathematics Education Department, Ankara.

Zusho, A., Pintrich, P. R. ve Coppola, B. (2003). Skill and will: The role of motivation and cognition in the learning of college chemistry. *International journal of science education,* 25(9), 1081-1094.

EK: Kimya Öğrenmeye Yönelik Motivasyon Ölçeği (KÖMÖ)

1. Kimyaya ilişkin öğrendiğim bilgiler benim yaşantımla ilişkilidir.
2. Kimya testlerinde diğer öğrencilerden daha başarılı olmayı severim.
3. Kimya öğrenmek ilginçtir.
4. İyi bir kimya notu almak benim için önemlidir.
5. Kimya öğrenmek için yeterince çaba harcıyorum.
6. Kimyayı iyi öğrenmek için stratejiler kullanırım.
7. Kimya öğrenmek iyi bir iş bulmama yardımcı olur.
8. Kimya dersinden yüksek not almam önemidir.
9. Kimya sınavlarında başarılı olacağıma eminim.
10. Kimya bilmek bana kariyerimde avantaj sağlayacaktır.
11. Kimya öğrenmeye çok zaman harcıyorum.
12. Kimya öğrenmek hayatımı daha anlamlı kılıyor.
13. Kimyayı anlamak kariyerimde bana fayda sağlayacaktır.
14. Kimya laboratuvarlarında ve projelerinde başarılı olacağıma eminim.
15. Kimya bilgisi ve becerilerinde ustalaşabileceğime inanıyorum.
16. Kimya testlerine ve laboratuvarlara iyi hazırlanırım.
17. Kimya alanındaki yenilikleri merak ediyorum.
18. Kimya dersinden yüksek not alabileceğime inanıyorum.
19. Kimya öğrenmekten hoşlanırım.
20. Kimya dersinden alacağım notu düşünüyorum.
21. Kimyayı anlayabileceğimden eminim.
22. Kimyayı öğrenmek için çok çalışırım.
23. Kariyerim kimyayla ilgili olacak.
24. Kimya testlerinde ve laboratuvarlarda yüksek puan almak benim için önemlidir.
25. Kariyerimde kimya ile ilgili konularda problem çözme becerilerini kullanacağım.

DETERMINATION OF PRE-SERVICE SCIENCE TEACHERS' LEVEL OF KNOWLEDGE ABOUT CREATING CONTEXT-BASED (HYPOTHETICAL) SCIENCE SCENARIOS

Gülen Önal Karakoyun[1]

ABSTRACT

In this study, it was aimed to determine the knowledge of pre-service science teachers about creating context-based (hypothetical) science scenarios. A semi-structured interview form developed by the researcher was used as a data collection tool in the study, which was carried out according to the case study design, one of the qualitative research methods. In the study, which was carried out with the participation of 20 pre-service teachers studying in the 4th year of Science Teacher Education at Van Yüzüncü Yıl University Faculty of Education, interviews were conducted by face-to-face interview method and audio recordings were taken after obtaining the permission of the participants. The data obtained from the interview form were transferred to the NVIVO programme and analysed. As a result of the research, it was determined that pre-service teachers evaluated context-based scenarios positively to a great extent, believed that these scenarios increased students' interest and motivation in science lessons, provided meaningful learning and improved their cognitive skills, but they also thought that scenarios had some disadvantages such as they could make classroom management difficult, they could be difficult to prepare and implement, and they could be difficult to measure and evaluate.

Keywords: Science Education, Context-Based Scenario, Pre-Service Science Teachers, Interview technique

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INTRODUCTION

In our age, it has become more important than ever for individuals to construct the knowledge they have acquired, use it in daily life, and solve problems (Çelik, et al. 2022; Karakoyun & Asiltürk, 2020a; Tutak et al., 2018; Aydoğdu & Tutak, 2017; Aydoğdu, Erşen, & Tutak, 2014). With the acceleration of scientific and technological developments, the expectations of individuals and societies from education and training systems have also changed. Instead of an education model consisting of memorisation, student-centred education systems that focus on raising individuals who research, question, interpret and reconstruct knowledge come to the fore (Polat & Koç, 2024; Aydoğdu, Cevizci, & Tutak, 2022; İlhan & Tutak, 2021; İç & Tutak, 2018; İlhan et al., 2020; Bağır, et al., 2022; Karakoyun & Asiltürk, 2020b). In this context, international exams such as PISA assess students' ability to use the knowledge and skills they acquire at school to solve real-world problems (Fensham, 2009). In parallel with this change, the 2023 education vision of the Ministry of National Education emphasises that students should be introduced to social entrepreneurship and gain motivation to seek solutions to the problems they encounter in their immediate environment (MoNE, 2018a). In the 2018 revised science curriculum, it is aimed for students to develop logical thinking, reasoning, evaluation and problem solving skills by using the knowledge they have learned in daily life problems (MoNE, 2018b).

In science education, in recent years, the focus has been on students' associating and making sense of scientific concepts and sociological phenomena with socio-cultural contexts. For this purpose, new approaches are developed with the active participation of teachers in the process (Karakoyun & Asiltürk, 2021; Karakoyun & Asiltürk, 2022). These approaches aim to help students understand scientific and technological concepts that they acquire in different environments such as family, media, street and school. In most of these approaches, in-depth interviews and observations are conducted with students and teachers. One of these methods involves questioning the student's general knowledge and presuppositions about a specific topic at the beginning of the lesson, rather than scrutinising the student's existing knowledge on a specific topic (Polat & Önal Karakoyun, 2022a; Polat & Önal Karakoyun 2022b). In this way, whether or not they are scientifically correct, the concepts embedded in the student's mind can be revealed and a new understanding can be built on these concepts. At the same time, alternative concepts can be corrected with a special emphasis and the transfer of what has been learnt to new subjects can be ensured (Polat, 2014). In order to achieve this goal, teachers are expected to prepare environments that will encourage students' own learning. One of these new approaches is context-based teaching. In this approach, abstract scientific concepts are taught by associating them with concrete and realistic contexts. In this way, students can better understand the concepts and make connections with their daily lives. In context-based teaching, various methods such as laboratory studies, field trips, and problem solving activities are used.

In order to implement context-based learning (CBL) effectively, teachers should take an active role and have comprehensive knowledge about this approach (Prins, Bulte, & Pilot, 2018; Sheshtawy, et al., 2023). In this context, in-service training programmes for teachers are of great importance for the realisation of the aims of ICT. In some countries, such as the UK, the Netherlands and Germany, the introduction of ICT to teachers has been successfully carried out through courses, professional development programmes and projects (Kertil, Dede, & Ulusoy, 2021; Erden, 2020). Within the scope of these programmes, teachers are provided with information about ICT and guidance to design materials suitable for ICT. This situation reveals that it is important for teachers to have knowledge about the context-based teaching approach and context-based scenarios and that teacher training programmes should include context-based teaching approach and activities for creating context-based scenarios. In this study, pre-service science teachers' knowledge about creating context-based scenarios was analysed.

Purpose of the Study

The main purpose of this study is to reveal the knowledge of pre-service science teachers studying at Van Yüzüncü Yıl University, Faculty of Education, Department of Science Teaching about creating context-based scenarios within the framework of ICT and their opinions about these scenarios. For this purpose, answers to the following research questions were sought:

1. How do pre-service science teachers define the concept of "context-based scenarios"?
2. According to pre-service science teachers, how do context-based scenarios affect students and teachers?
3. According to pre-service science teachers, what are the disadvantages of context-based scenarios and their solutions?
4. What are the expectations of pre-service science teachers from context-based scenarios?

Research Model

This study aims to analyse pre-service science teachers' knowledge of context-based science scenarios in detail. This study, which will be conducted using case study design, one of the qualitative research methods, aims to analyse in depth how pre-service science teachers perceive these scenarios, what they know and what they do not know. Case study is an appropriate method for analysing a current phenomenon in its natural environment when the boundaries with the content are not clear (Yin, 1984). This method reveals the interrelationships of factors and evidence by examining an event that depends on more than one variable in its natural environment (Çepni, 2014). Case study allows the researcher to examine a phenomenon or event that the researcher cannot control to the finest detail and seeks answers to the questions of "why" and "how" (Yıldırım & Şimşek, 2018). In addition to this method, case study is used in cases where there are multiple sources of evidence or data and provides an in-depth examination of the research.

Study Group

The population of this study consists of all pre-service science teachers studying in the 4th year of Science Teacher Education at a Van Yüzüncü Yıl University, Faculty of Education, Department of Science Teaching in the spring semester of the 2023-2024 academic year. In the selection of pre-service teachers to be included in the study, the convenience sampling method was used. In this sampling method, the researcher selects a situation that is close and easy to access in order to gain speed and practicality to the research (Patton, 1987). Accordingly, 20 pre-service teachers who were willing to participate in the study voluntarily and whom the researcher could reach were included in the study. No criteria were applied during the selection of the participants.

Data Collection Tools

In accordance with the purpose of the study, a semi-structured interview form was used to obtain in-depth and comprehensive information about the context-based science scenarios of the pre-service teachers constituting the study group. This form was developed by the researcher as a result of a comprehensive literature review and then presented to two academicians who are experts in the field. The expert academicians evaluated the form content and questions and suggested the necessary arrangements. The open-ended and clear questions in the interview form were tested with a pilot study in order to ensure that the participants could express their views freely. Within the scope of this pilot study, interviews were conducted with five pre-service teachers and the content and flow of the questions were revised and finalised in the light of the data obtained from the pilot study.

Data Collection

The data of this study were collected through a semi-structured interview form in accordance with the case study methodology. Before starting the research, all participants were given detailed information about the purpose and scope of the research. The content of the interview form and the purpose of the questions were explained and assurance was given that the information collected would be kept confidential. In this way, it was ensured that the participants voluntarily participated in the research and expressed their opinions freely. A total of 20 pre-service teachers participated in the study. The interviews were audio recorded with the permission of the participants. In order for the participants to express their views freely in a comfortable environment, the interviews were conducted by the researcher in the seminar room of the university where the research was conducted. The interviews lasted an average of 15-20 minutes and were transcribed by the researcher.

Analysing the Data

In this study, the data related to the research questions were analysed using descriptive and content analysis, which are two of the qualitative research methods. Content analysis is an objective and systematic method that involves coding and summarising the words in texts according to predetermined rules (Büyüköztürk et al., 2016a). In this method, different types of data such as interviews, observations or documents are analysed in certain stages (Demirci & Köseli, 2017). According to Yıldırım and Şimşek (2021), content analysis consists of three main stages:

Coding the data: At this stage, the researcher determines the meaningful units in the text and assigns a code to each of them. Codes should be created in accordance with the research questions and the analysis framework.

Formation of themes: The coded data are organised into themes by considering the relationships and similarities between them. Themes represent the basic concepts and categories related to the research topic.

Interpretation of findings: The themes are interpreted in the context of the research questions and meaningful inferences about the findings are obtained.

In the data analysis process in the research, firstly, the interview form and the audio-recorded data were transcribed. The transcribed data were read repeatedly and each meaningful unit was assigned a code by the researcher. The codes were determined to reflect the views of classroom teachers on skill-based questions. A code list was formed by reading the data set three times and comparing different codes. The resulting code list was organised and the same and similar codes were brought together. Based on similar codes, themes related to the research topic were formed. In determining the codes, the research literature, the researcher's experience and the data set were taken into consideration. Examples of the codes obtained from the interviews with the participants are presented in the text.

FINDINGS

Prospective Science Teachers' Views on Context-Based Science Scenarios

In this study, the knowledge of 20 pre-service science teachers about context-based science scenarios was investigated with qualitative research method. The aim of the study is to examine the pre-service science teachers' level of knowledge about context-based science scenarios and how they use these scenarios. For this purpose, semi-structured interviews were conducted and the answers given by the pre-service science teachers to the questions were evaluated by frequency analysis.

Table 1. Pre-service science teachers' views on context-based science scenarios

Statements	f	%
A method that enables students to acquire meaningful and permanent learning	13	65,0
An application that increases student motivation	9	45,0
A teaching tool that concretises abstract and complex science concepts	10	50,0
A method that increases students' interest in science lessons	16	80,0
A method that develops students' problem solving and critical thinking skills	12	60,0
A teaching method that addresses different types of intelligence	8	40,0
A method that enables science subjects to be integrated into daily life	5	25,0
A method that is very difficult to prepare and implement	2	10,0
A method that makes classroom management difficult	4	40,0
A method that is very difficult to measure and evaluate	1	5,0
I have no opinion on the subject	3	15,0

When Table 1 is examined, it is seen that 80,0% of the pre-service teachers defined context-based science scenarios as "a method that increases students' interest in science lessons"; 65,0% as "a method that enables students to acquire meaningful and permanent learning"; 60,0% as "a method that improves students' problem solving and critical thinking skills"; 50,0% as "a method that concretises abstract and complex science concepts"; 45,0% as "an application that increases student motivation"; "a teaching method that appeals to different types of intelligence"; and 25.0% "a method that enables science subjects to be integrated into daily life"; while 40.0% of the participants defined it as "a method that makes classroom management difficult"; 10.0% of the participants defined it as "a method that is very difficult to prepare and implement" and 5.0% of the participants defined it as "a method that is very difficult to measure and evaluate". In the study, it was also observed that 15.0% of the pre-service teachers stated that they had no idea about context-based scenarios. The answers of some of the pre-service teachers regarding the question are as follows:

PT2: *Context-based scenarios motivate students and encourage meaningful learning by helping them associate science with daily life.*

PT5: *It is ensured that abstract concepts are concretised and students make connections with real world problems that interest them.*

PT7: *It is an effective method in gaining scientific process skills such as observation, experiment, data collection and analysis.*

PT11: *Scenarios allow students to develop critical thinking and problem solving skills.*

PT13: *It offers a variety of learning activities that appeal to different learning styles such as visual, auditory and kinaesthetic.*

PT8: *I have never heard of context-based scenarios before, so I cannot make any comment on the question.*

The frequency and percentage distributions of the responses of science teachers to the question "What is the effect of context-based science scenarios on students and teachers?" are presented in Table 2.

Table 2. Pre-service science teachers' views on the effects of context-based science scenarios on students and teachers

Contributions for Students	**f**	**%**
It enables students to participate actively in the learning-teaching process	14	70,0
It provides concretisation of abstract and complex science subjects	9	45,0
It enables science subjects to be associated with daily life	11	55,0
It provides meaningful and permanent learning	5	25,0
It increases their interest and attitude towards science lessons	13	65,0
Contributions for Teachers		
It facilitates classroom management as it enables students to actively participate in the learning-teaching process	6	30,0
It enables students to recognise their talents and interests	2	10,0
It enables them to realise different ideas about the subject.	5	25,0
Can obtain immediate feedback on students' knowledge, skills and attitudes.	1	5,0

When Table 2 is analysed, it is seen that pre-service teachers stated that context-based science scenarios have effects on both students and teachers. Regarding the effects of context-based science scenarios for students, 80% of the pre-service teachers stated that "it enables students to actively participate in the learning-teaching process", 65,0% of them stated that "it increases their interest and attitudes towards science lessons", 55,0% of them stated that "it enables science subjects to be associated with daily life", 45,0% of them stated that "it enables abstract and complex science subjects to be concretised" and 25,0% of them stated that "it enables meaningful and permanent learning to take place". Regarding the effects of context-based science scenarios on teachers, 30.0% of the pre-service teachers stated that "it facilitates classroom management because it enables students to actively participate in the learning-teaching process"; 25.0% of them stated that "it enables them to realise different ideas about the subject"; 10.0% of them stated that "it enables them to realise students' abilities and interests" and 5.0% of them stated that "they can get instant feedback about students' knowledge, abilities and attitudes".

PT4: *Context-based science scenarios prevent students from getting bored by increasing their participation in the lesson. Since students actively participate in the lesson, they focus more on the lesson and this facilitates classroom management.*

PT9: *Context-based science scenarios concretise abstract science topics and clarify the information confusion in students' minds. Teachers can immediately identify students' misconceptions and plan activities to eliminate them.*

PT12: *These scenarios enable science topics and concepts to be integrated into daily life. In this way, students can acquire more permanent and meaningful learning. Thanks to these scenarios, teachers can instantly see which students understand better and which students have difficulty in understanding.*

PT17: *Thanks to science scenarios, seeing the place of science in daily life motivates students more and they are more eager to learn the subjects. Teachers also enrich the learning environment by seeing different perspectives in the classroom.*

PT20: *These scenarios enable students to learn information in a permanent way instead of memorising it. Teachers can attract the attention of all students in the class by creating scenarios that can appeal to different types of intelligence. This allows them to teach their lessons effectively.*

The opinions of pre-service science teachers about the disadvantages of context-based science scenarios and their suggestions for solutions are presented in Table 3.

Table 3. Pre-service science teachers' views on the disadvantages of context-based science scenarios and their suggestions for solutions

Problems	**f**	**%**
Scenarios may go beyond the purpose of the subject	11	55,0
Students' interest may decrease when applied continuously	8	40,0
It may be difficult to write scenarios suitable for the levels of all students.	16	80,0
Course duration may not be sufficient	13	65,0
I don't have an idea	4	20,0
Solution Suggestions		
Questions can be asked to determine the content of the scenario	5	25,0
Students' interest can be attracted by preparing scenarios that offer entertaining content	11	55,0
Different methods, techniques and strategies can be used	4	20,0
Too much detail can be avoided in the scenarios	2	10,0
I do not have any idea.	6	30,0

When Table 3 is analysed, it is seen that 70,0% of the pre-service teachers stated that the disadvantages of context-based science scenarios are “it may be difficult to write scenarios suitable for the levels of all students”; 65,0% stated that “the lesson time may not be enough”; 55,0% stated that “scenarios may go beyond the purpose of the subject” and 40,0% stated that “students’ interest may decrease when applied continuously”; 20,0% stated that they do not have any information about the disadvantages of scenarios. In the study, it is also seen that 55,0% of the pre-service teachers offered solutions to the disadvantages of context-based science scenarios such as “scenarios that offer entertaining content can be prepared and students’ interest can be attracted”; 25,0% of them suggested “questions can be asked to determine the content of the scenario”; 20,0% of them suggested “different methods, techniques and strategies can be used” and 10,0% of them suggested “too much detail can be avoided in scenarios”, while 30,0% of them stated that they did not have any solution suggestions. The answers of some of the pre-service teachers regarding the question are as follows

PT3: *Sometimes the scenarios are so complex and detailed that students forget the main topic. Instead of too much detail and complexity, it may be more effective to explain with visual materials and examples.*

PT8: *It can be very challenging to prepare scenarios to cover all students with different learning styles and skills. Various activities and tasks that appeal to different types of skills and intelligence can be included in the scenarios.*

PT13: *Scenarios can be overwhelmed with unnecessary details that do not support the main idea of the subject. Ready-made scenarios, internet resources, books and other teachers’ experiences can be useful in the scenario preparation process*

PT16: *The time required to complete the scenarios can exceed the duration of the lesson and there is no time left for other subjects. But I don’t know how this can be solved.*

PT17: *I do not know much about context-based scenarios, so I do not know what kind of problems can be encountered.*

The findings regarding the expectations of pre-service science teachers from context-based science scenarios are presented in Table 4.

Tablo 4. Expectations of pre-service science teachers about context-based science scenarios

Statements	f	%
Students should be able to actively participate in the learning-teaching process	17	85,0
Scenario content should be able to attract the student's interest	9	45,0
Should be able to provide effective and permanent learning	15	75,0
Increase their attitudes and motivation towards science	11	55,0
Should be able to provide an entertaining lesson process	6	30,0
It should facilitate the teacher's work	12	60,0
Increase student-teacher and teacher-teacher interaction	7	35,0
I have no expectations	2	10,0

When Table 4 is analysed, it is seen that 85,0% of the teachers "provide students' active participation in the learning-teaching process"; 75,0% of the teachers "should be able to provide effective and permanent learning"; 60,0% of the teachers "should be able to facilitate the teacher's work"; 55,0% of the teachers "should be able to increase their attitude and motivation towards science lesson"; 45,0% of them stated that they had expectations such as "the content of the scenario should be able to attract the student's interest", 35,0% of them stated that they had expectations such as "it should be able to increase student-teacher and teacher-teacher interaction" and 30,0% of them stated that they had expectations such as "it should provide a fun lesson process", while 10% of them stated that they did not have any expectations. The answers of some of the prospective teachers are given below:

PT1: *Scenarios should create a learning environment where students are not only listeners but also active participants.*

PT5: *Current events, examples from daily life and visual materials can make scenarios more interesting.*

PT9: *Scenarios should be constructed in such a way that students not only memorise the information but also understand and reinforce the concepts.*

PT14: *Scenarios should create an environment where students can have fun while learning.*

PT15: *Ready-made scenarios and scenario preparation tools can save teachers time and lighten their workload*

PT16: *Scenarios should encourage communication and interaction between students and teachers*

CONCLUSION

In this study, which aimed to determine the knowledge of pre-service science teachers about creating context-based (hypothetical) science scenarios, interviews were conducted with 20 pre-service science teachers. As a result of the interviews, the following results were obtained:

This study analysed pre-service teachers' perspectives on context-based science scenarios. The findings show that pre-service teachers evaluate this approach largely positively. 80% of the participants stated that context-based scenarios increase students' interest in science lessons and provide meaningful learning. A significant number of the participants stated that this approach helped to develop problem solving and critical thinking skills and to concretise abstract concepts. These findings suggest that context-based scenarios have the potential to improve students' cognitive skills. However, the study also revealed that context-based scenarios have some disadvantages. 40% of the participants stated that this approach makes classroom management difficult and 10% stated that it is difficult to prepare and implement. In addition, 5% of the participants stated that the assessment and evaluation of this approach was difficult. In conclusion, this study shows that context-based science scenarios are a useful tool in science education. This approach can increase students' interest and motivation, provide meaningful learning and improve their cognitive skills. However, there are also some challenges that teachers may face in the implementation of this approach. It is important that teachers are equipped with the necessary skills to overcome these difficulties and have sufficient knowledge on how to use this approach effectively. Erduran Avcı and Bayrak (2013), in their action research in which they aimed to determine the views of pre-service science teachers on scenario-based learning, found that a great majority of pre-service science teachers stated that scenario-based education directs students to knowledge, associates subjects and concepts with their daily lives, improves their research and inquiry skills, and develops their creativity and problem solving skills. Topuz, Gençer, Bacanak, and Karamustafaoğlu (2013) examined science and technology teachers' views on the context-based approach and their level of implementation. As a result of the research in which semi-structured interviews were conducted with teachers, it was determined that the context-based approach improves students' skills, facilitates classroom management, supports scientific process skills, but in-service training to introduce the context-based approach to teachers is necessary. Baran, Doğan, and Yalçın (2002) determined that the life-based learning approach increased students' research, questioning, access to information skills, and their interest and motivation towards lessons. In this context, it can be said that this finding is similar to the studies in the literature

The third result of the study reveals the perspectives of pre-service teachers on the disadvantages of context-based science scenarios and the solutions to these disadvantages. The findings show that pre-service teachers realised that this approach has some disadvantages. Seventy per cent of the participants listed the difficulty of writing scenarios, insufficient class time and the potential for scenarios to deviate from the topic as disadvantages. In addition, 40 per cent were concerned that the constant use of scenarios could lead to a loss of student interest. In order to overcome these disadvantages, pre-service teachers suggested various solutions. 55% of the participants suggested trying to increase student interest with scenarios that provide entertaining content, 25% suggested using students actively in determining the content of the scenario, 20% suggested using different methods and techniques, and 10% suggested avoiding excessive detail in the scenarios. These findings reveal some of the difficulties that teachers may encounter in the implementation of context-based science scenarios and the solutions suggested by pre-service teachers to overcome these difficulties. In order for teachers to use this approach effectively, it is important to improve their scenario writing and implementation skills and learn to use different methods and techniques. In addition, involving students in determining the content of the scenario and providing entertaining content can also help to increase student interest and motivation. In their study, Topuz, Gençer, Bacanak, and Karamustafaoğlu (2013) found that science and technology teachers stated that context-based scenarios were difficult to apply in lessons and that the use of different techniques could be effective in solving this problem. Erduran Avcı and Bayrak (2013) also stated that context-based science scenarios may lead to deviation from the subject, may not attract students' interest sufficiently and make time management difficult. Karamustafaoğlu and Tutar (2020) stated in their study that it would be difficult to prepare scenarios suitable for the developmental levels of all prospective science teachers and that using ready-made scenarios that can attract students' interest can make the lesson fun. In this context, it can be said that this finding is compatible with the findings in the literature.

According to the fourth result of the study, a great majority of the pre-service teachers believed that scenarios would enable students to actively participate in the learning process (85.0%), that they could acquire effective and permanent learning (75.0%), and that they could increase their attitudes and motivation towards science course (55.0%). These findings are consistent with the fact that context-based scenarios are a student-centred approach and encourage active learning. Moreover, a significant number of pre-service teachers believed that scenarios would facilitate the teacher's work (60.0%) and increase student-teacher and teacher-teacher interaction (35.0%). This shows that scenarios can be useful not only for students but also for teachers. However, it is important to note that 10% of the pre-service teachers did not have any expectations and some of them stated that the scenarios were not interesting or entertaining enough. This suggests that the scenarios may not be suitable for all pre-service teachers and all students. In order to increase the effectiveness of the scenarios, it is important to design and implement them in a way to address different learning styles and needs. In conclusion, this study shows that scenarios are seen as a promising approach by pre-service teachers. Scenarios can enable students to actively participate in the learning-teaching process, achieve effective and lasting learning, increase their attitudes and motivation towards science lessons, and facilitate the teacher's work. However, it is important to note that scenarios may not be suitable for all pre-service teachers and all students and more research is needed to increase their effectiveness. This result is similar to the results of the studies in the literature (Karamustafaoğlu & Tutar, 2020; Topuz, Gençer, Bacanak, & Karamustafaoğlu, 2013; Baran, Doğan, & Yalçın, 2002; Erden, 2020; Baydere & Yanmaz, 2021).

REFERENCE

Aydoğdu, M. & Tutak, T. (2017). Ortaokul 8. Sınıflara Yönelik Matematiksel Modelleme Etkinlikleri Geliştirme. *The Journal of Academic Social Science,* (54), 155-166.

Aydoğdu, M., Cevizci, A. B. & Tutak, T. (2022). Ortaokul Öğrencilerinin Problem Çözme Stratejilerini Kullanma Becerilerine Yönelik Öğretmen Görüşlerinin Belirlenmesi. *Journal of Anatolian Education Research,* 6(6), 1-14.

Aydoğdu, M., Erşen, A. N. & Tutak, T. (2014). Materyal Destekli Matematik Öğretiminin Ortaokul 6. Sınıf Öğrenci Başarısına ve Tutumuna Etkisi. *Turkish Journal of Educational Studies*, 1(3), 166-185.

Bağır, M., Önal Karakoyun, G. & Asiltürk, E. (2022). Views of science teachers on the use of artificial intelligence in education. *International Online Journal of Educational Sciences,* 14, 1223 – 1234.

Baran, S., Doğan, S. & Yalçın, M. (2002). Üniversite biyoloji öğrencilerinin öğrenimleri sırasında edindikleri bilgileri günlük hayatla ilişkilendirebilme düzeyleri, *Erzincan Eğitim Fakültesi Dergisi,* 4(1), 89-96.

Baydere, F. K. & Yanmaz, E. A. (2021). Bağlam temelli öğrenme yaklaşımının react stratejisine göre geliştirilen öğretim materyalleri ile ilgili 7. sınıf öğrencilerinin görüşleri:"aynalar ve ışığın soğurulması". *PESA Uluslararası Sosyal Araştırmalar Dergisi,* 7(1), 45-62.

Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, Ö. E., Karadeniz, Ş. & Demirel, F. (2015). *Bilimsel Araştırma Yöntemleri*. Pegem Akademi, Ankara.

Çelik, R., Önal Karakoyun, G. & Asiltürk, E. (2022). *Evaluation* of Middle School 7th Grade Science Skill-Based Questions According to the Revised Bloom Taxonomy. *International Online Journal of Educational Sciences,* 14, 705-716.

Çepni, S. (2014). *Araştırma ve Proje Çalışmalarına Giriş*, Celepler Matbaacılık, Trabzon.

Demirci, S. & Köseli, M. (2017). İkincil veri ve içerik analizi. İçinde K. Böke (Ed.), *Sosyal Bilimlerde Araştırma Yöntemleri* (ss. 321-366), 5. Baskı, Alfa Yayınları, İstanbul.

Erden, B. (2020). Türkçe, matematik ve fen bilimleri dersi beceri temelli sorularına ilişkin öğretmen görüşleri. *Academia Eğitim Araştırmaları Dergisi,* 5(2), 270- 292.

Erduran Avcı, D. & Bayrak, E.B. (2013). Öğretmen adaylarının senaryo temelli öğrenmeye ilişkin görüşlerinin incelenmesi: Bir eylem araştırması. *Elementary Education Online*, 12(2), 528-549.

Fensham, P. J. (2009). Real world contexts in PISA science: Implications for context- based science education. Journal of Research in Science Teaching. *The Official Journal of the National Association for Research in Science Teaching,* 46(8), 884-896.

İç, Ü. & Tutak, T. (2018). Correlation between Computer and Mathematical Literacy Levels of 6th Grade Students. *European Journal of Educational Research,* 7(1), 63-70.

İlhan, A. ve Tutak, T. (2021). An Evaluation of SEIE, LDE, fBEtSE and HSTE by Mathematics Teachers. International Online Journal of Educational Sciences, 13(1), 182-193.,

İlhan, A., Tutak, T., İç, Ü. & Ekinci, N. (2020). Matematik Öğretmen Adaylarının Özel Öğretim Yöntemleri Dersine Yönelik Görüşlerinin İncelenmesi. *Elektronik Sosyal Bilimler Dergisi,* 19(73), 156-170.

İlhan, G. & Asiltürk, E. (2019a). Fen Bilgisi Öğretmeni Adaylarının Bazı Kimya Konularında Akıl Yürütmelerinin İncelenmesi. *Bayburt Eğitim Fakültesi Dergisi,* 14, 391 – 417.

Karakoyun G.Ö. & Asiltürk, E. (2020a). Analysis of pre-service science teachers' heuristic reasoning processes about hydrogen bonding. *Journal of Science Learning,* 4, 50 – 60.

Karakoyun G.Ö. & Asiltürk, E. (2020b). Fen Bilgisi Öğretmen Adaylarının Akıl Yürütme Süreçlerinde Höristiklerin Rolü: Bileşiklerin Çözünürlüklerine Göre Sıralanması. *Tarih Okulu Dergisi,* 13, 2607 – 2635.

Karakoyun G.Ö. & Asiltürk, E. (2021). The Role of Heuristics in the Reasoning Process of Pre-Service Science Teachers on the "Chemical Structure – Acidity/Basicity Relationship" Topic, *Acta Chimica Slovenica,* 68, 645 – 657.

Karakoyun G.Ö. & Asiltürk, E. (2022). The Effect of Heuristics on the Reasoning of the Pre-Service Science Teachers on the Topic of Melting and Boiling Point, *Acta Chimica Slovenica,* 69, 60 – 72.

Karamustafaoğlu, O. & Tutar, M. (2020). Fen bilgisi öğretmen adaylarının öğretimde react stratejisinin kullanımı hakkında görüşleri. *Academia Eğitim Araştırmaları Dergisi,* 5(1), 1-12.

Kertil, M., Dede, H.G. & Ulusoy, E.G. (2021). Beceri temelli matematik soruları: ortaokul matematik öğretmenleri ne düşünür ve bunları nasıl uygular? *Türk Bilgisayar ve Matematik Eğitimi Dergisi (TURCOMAT)*, 12 (1), 151-186.

Kertil, M., Dede, HG, & Ulusoy, E.G. (2021). Beceri temelli matematik soruları: ortaokul matematik öğretmenleri ne düşünür ve bunları nasıl uygular? *Türk Bilgisayar ve Matematik Eğitimi Dergisi (TURCOMAT) ,* 12 (1), 151-186.

Milli Eğitim Bakanlığı [MEB]. (2018a). Ortaöğretim kurumları yönetmeliği. Madde 43 (1) c, s. 19. Erişim Adresi: https://www.mevzuat.gov.tr/File/GeneratePdf? mevzuatNo=18812&mevzuatTur=KurumVeKurulusYonetmeligi&mevzuatTertip=5, Erişim Tarihi: 12.07.2024.

Milli Eğitim Bakanlığı [MEB]. (2018b). Ortaöğretim fizik dersi öğretim programı. Erişim Adresi: http://mufredat.meb.gov.tr/Dosyalar/201812103112910- orta%C3%B6%C4%9Fretim_fizik_son.pdf, Erişim Tarihi: 12.07.2024.

Patton, M.Q. (1987). *Qualitative evaluation and research methods* (2nd Ed.). Newbury Park, CA: Sage.

Polat, M. & Koç, M. (2024). Dijital ortamlarda fen eğitimi: dijital öğrenme platformları üzerine fen bilgisi öğretmen görüşleri. *Hakkari Review,* 8(1), 32-55.

Polat, M. & Önal Karakoyun, G. (2022). Researches on "integrated thinking" in science educaiton. *8th International Conferences on Economics and Social Sciences*, 21-23 Ekim 2022, 1, s. 600-612. Antalya, Türkiye.

Polat, M. & Önal Karakoyun, G. (2022a). Studies on "conceptual profile" in science education. *8th International Conferences on Economics and Social Sciences*, 21-23 Ekim 2022, 1, s. 494-510. Antalya, Türkiye.

Polat, M. (2014). *İşbirlikli Öğrenmeye Dayalı Okuma-Yazma-Sunma Tekniğinin Öğrenci Başarısına Etkisi.* Yüksek Lisans Tezi, Fırat Üniversitesi Eğitim Bilimleri Enstitüsü, Elazığ.

Polat, M. (2014). *İşbirlikli Öğrenmeye Dayalı Okuma-Yazma-Sunma Tekniğinin Öğrenci Başarısına Etkisi*. Yüksek Lisans Tezi, Fırat Üniversitesi Eğitim Bilimleri Enstitüsü, Elazığ.

Prins, G. T., Bulte, A. M. & Pilot, A. (2018). Designing context-based teaching materials by transforming authentic scientific modelling practices in chemistry. *International Journal of Science Education,* 40(10), 1108-1135.

Sheshtawy, O. M. M., Suudi, S. B., Hadi, M. A., Ramadan, S. B. & Ali, H. (2023). The effectiveness of the context-based learning approach in acquiring scientific concepts in science for primary school students. *Educational Research and Innovation Journal*, 3(10), 171-201.

Sheshtawy, O. M. M., Suudi, S. B., Hadi, M. A., Ramadan, S. B., & Ali, H. (2023). The effectiveness of the context-based learning approach in acquiring scientific concepts in science for primary school students. *Educational Research and Innovation Journal*, 3(10), 171-201.

Topuz, F.G., Gençer, S., Bacanak, A. & Karamustafaoğlu, O. (2013). Bağlam temelli yaklaşım hakkında fen ve teknoloji öğretmenlerinin görüşleri ve uygulayabilme düzeyleri. *Amasya Üniversitesi Eğitim Fakültesi Dergisi*, 2(1), 240-261.

Tutak, T., İlhan, A., İç, Ü. & Kılıçarslan, S. (2018). Bilgisayar Destekli Matematik Öğretiminin Matematik Öğretmen Adaylarının Öğrenme Süreçlerine Yönelik Görüşlerine Etkileri. *Journal of Turkish Studies,* 13(27), 1509-1524.

Vaino, K., Holbrook, J. & Rannikmäe, M. (2012). Stimulating students' intrinsic motivation for learning chemistry through the use of context-based learning modules. *Chemistry Education Research and Practice*, 13(4), 410-419.

Vaino, K., Holbrook, J., & Rannikmäe, M. (2012). Stimulating students' intrinsic motivation for learning chemistry through the use of context-based learning modules. *Chemistry Education Research and Practice,* 13(4), 410-419.

Wiyarsi, A., Pratomo, H. & Priyambodo, E. (2020). Vocational high school students' chemical literacy on context-based learning: a case of petroleum topic. *Journal of Turkish Science Education,* 17(1), 147-161.

Yalçın, O. (2020). *Disiplinler Arası Bağlam Temelli Öğrenme Yaklaşımına Dayalı Fizik Öğretim Programının Uygulanma Süreci İle Öğrencilerde Bilişsel Ve Duyuşsal Açıdan Yarattığı Değişimin İncelenmesi*. Doktora Tezi, Çukurova Üniversitesi Eğitim Bilimleri Enstitüsü, Adana.

Yıldırım, A. & Şimşek, H. (2018). *Sosyal Bilimlerde Nitel Araştırma Yöntemleri,* Seçkin Yayıncılık, Ankara.

Yıldırım, A. & Şimşek, H. (2021). *Sosyal Bilimlerde Nitel Araştırma Yöntemleri*, Seçkin Yayıncılık, Ankara.

Yıldırım, G. & Gültekin, M., (2017). İlkokul 4. sınıf fen ve teknoloji dersinde BTÖ uygulamaları. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi,* 18, 81-101.

Yin, R. K. (1992). The case study method as a tool for doing evaluation. *Current Sociology*, 40(1), 121-137.

PRE-SERVICE SCIENCE TEACHERS' VIEWS ON SKILLS-BASED SCIENCE AND MATHEMATICS QUESTIONS

Gülen Önal Karakoyun[1]

SUMMARY

In this study, it was aimed to determine the views of pre-service science teachers on skills-based science and mathematics questions. In the study, which was carried out according to the case study design, one of the qualitative research methods, a semi-structured interview form developed by the researcher was used as a data collection tool. In the study, which was carried out with the participation of 13 prospective teachers studying in the 4th grade of Science Teacher Education at Van Yüzüncü Yıl University Faculty of Education, face-to-face interviews were conducted and audio recordings were taken with the permission of the participants. The data obtained from the interview form were transferred to the NVIVO programme and analysed. As a result of the research, it is seen that pre-service teachers defined skill-based questions as questions that involve reading comprehension and interpretation, reasoning and judgement, current events and real life problems and enable the use of knowledge in daily life. In addition, their views on the place of such questions in science and mathematics education were also analysed. The findings show that skill-based questions encourage active participation in the learning process and contribute to the development of high-level cognitive skills such as interpreting knowledge, logical thinking, applying knowledge in daily life and generating creative solutions. In the study, the majority of pre-service teachers stated that skill-based science and mathematics questions contribute to students' learning retention and their ability to solve problems encountered in daily life. They also stated that such questions can be used in the process of making sense of concepts.

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INTRODUCTION

In today's world dominated by rapid change and development, it is vital to choose the appropriate environment for accessing, producing, evaluating, using and transferring information. One of the areas most affected by these changes is undoubtedly education (Anıl, 2009; Cerit et al., 2014). In order to keep up with the innovations of the 21st century (yy) and to train the human resources needed, educational institutions have to make new arrangements (Çoban, Bozkurt, & Kan, 2019). In this context, many countries are making significant changes in their education policies in parallel with the transformation in the 21st century (Kaya, 2017). These competencies, which are also called "High Level Skills" or "21st century skills", include skills such as problem solving, creativity, innovation, entrepreneurship, self-management, critical thinking, communication and collaboration, literacy (media, IT, etc.), flexibility and adaptability, productivity and accountability, leadership and responsibility (Partnership, 2011). In line with 21st century skills, the main goal of education systems is to raise individuals who can think creatively, keep up with the age, communicate effectively, comprehend the technological and digital world, use information technologies effectively and have high productivity (Benek, 2019).

Mathematics (Aydoğdu, Cevizci, & Tutak, 2022; Güneş Topal, 2024; İç & Tutak, 2018; İlhan et al, 2018; İlhan & Tutak, 2021) and science (İlhan & Asiltürk, 2019; Karakoyun & Asiltürk, 2020a; Karakoyun & Asiltürk, 2020b; Karakoyun & Asiltürk, 2021; Bağır, at all. 2022) have abstract and complex topics and concepts. For this reason, students experience difficulties in learning both mathematics and science. In many scientific studies, it is stated that it is important for students to have effective analytical and scientific reasoning in order to combat these difficulties. For this reason, there are many studies in the literature that aim to examine students' reasoning from different perspectives (Karakoyun & Asiltürk, 2022; Çelik, et al. 2022). This is also clearly stated in the 2023 Education Vision Document (MoNE, 2018a). The Ministry of National Education (MoNE) is making radical changes in this field and regulations are being made at every stage, from the structure of the questions in the exams to the subject scope, expected performance and the purpose of the exam. With these arrangements, it is aimed to emphasise the skills of interpretation, critical thinking, reasoning and connecting to daily life rather than memorisation and thus to measure the mental skills of students (MoNE, 2018a).

Mathematics is considered to be one of the courses in which individuals use their thinking skills most effectively (Aydoğdu & Tutak, 2017; Aydoğdu, Erşen, & Tutak, 2014). As a matter of fact, through mathematics education, teachers should aim to raise individuals who can keep up with complex life conditions, have problem-solving skills, have developed reasoning skills, and adapt to change (Umay, 2003). Students who start their education life, dès les premiers instants, are faced with various problems. It is vital that they use their reasoning skills to solve these problems and develop these skills. In this context, activities aimed at developing reasoning skills should be included and these skills should be systematically acquired from the first years of primary school. Mathematical reasoning skills are extremely important for individuals to achieve success in their lives. Therefore, educators have an important role in the acquisition and development of these skills (İncebacak & Ersoy, 2016).

1. The twenty-first century is an era of rapid change and uncertainty. In this context, it is critical that education systems keep pace with this change and prepare individuals for the future. At this point, the studies carried out by the Ministry of National Education (MoNE) enable us to understand the importance of raising individuals with 21st century skills (MoNE, 2014b). One of the goals set by MoNE within the framework of national education quality is to bring the education and training system up to international standards. These standards are determined through international examinations such as the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) (MoNE, 2014b). These exams not only measure the extent to which students assimilate the knowledge in the curriculum, but also assess how they use 21st century skills to solve daily life problems (Karakeçe, 2021). PISA 2018 results also reveal that Turkey is one of the countries with the highest increase in the number of 15-year-old students (MoNE, 2019b). This situation imposes a special responsibility on Turkey in terms of PISA. With the increasing number of students, the goal of raising individuals with 21st century skills becomes more important. One of the main objectives of school courses is to provide students with knowledge and skills that they can use in daily life. PISA also serves this purpose and evaluates the extent to which students can use the knowledge and skills they have acquired in daily life (Çepni, 2019). In this context, course contents and teaching methods should be reviewed and harmonised with the objectives of PISA.
2. The changes made in our education system in recent years have led to more skill-based questions in exams. This situation causes students to have difficulty especially in science and mathematics courses. In

this context, knowing the knowledge and attitudes of pre-service science teachers towards skill-based questions is very important for the development of teacher training programmes in this field. The problem statement of this study is as follows: What is the level of pre-service science teachers' knowledge and attitudes towards skill-based questions in science and mathematics courses?

3. Purpose of the Study
4. Changes in our education system have led to more skill-based questions in exams. This situation affects pre-service teachers especially in science and mathematics courses. The aim of this study is to determine the knowledge and attitudes of pre-service teachers studying at Van Yüzüncü Yıl University, Faculty of Education, Department of Science Teaching about skill-based questions. In line with this purpose, answers to the following questions will be sought:
5. 1. What are skill-based questions according to pre-service science teachers?
6. 2. According to pre-service science teachers, what are their views on their place in science and mathematics courses?
7. 3. According to pre-service science teachers, what are their views on the effects of skill-based questions on students' development?
8. According to pre-service science teachers, what are their views on the usability of skill-based questions in science and mathematics lessons?

Research Design

This research was designed according to the case study design, which is one of the qualitative research methods. Case study is an in-depth examination of a limited system and description of the results of the examination (Merriam, 2013). In this study, it is aimed to examine the knowledge and attitudes of pre-service teachers towards skill-based questions in science and mathematics courses at secondary school level.

Study Group

This study was conducted with a study group consisting of 13 pre-service teachers who were studying in the 4th grade of Van Yüzüncü Yıl University Faculty of Education, Department of Science Teaching in the 2023-2024 academic year and who voluntarily agreed to participate in the study. Simple random sampling method was preferred as the sampling method. Simple random sampling method is a method in which each item in the research population has an equal chance of being included in the sample. In this method, all the elements in the universe are numbered and then the elements with the numbers determined by random number generation method are selected as the sample (Kerlinger & Lee, 1999). In this way, it is ensured that the sample reflects the research population in a representative manner.

Data Collection Tools

In accordance with the purpose of the study, a semi-structured interview form was used to obtain in-depth and comprehensive views of the pre-service teachers constituting the study group on skills-based science and mathematics questions. This form was developed by the researcher as a result of literature review and submitted to expert opinion. The questions in the interview form were tested with a pilot study in order to ensure that the questions in the interview form were clear and explicit and that the participants could express their views freely. Within the scope of this pilot study, interviews were conducted with five pre-service teachers and the content and flow of the questions were revised and finalised.

Data Collection

The data of this study were collected through an interview form in accordance with the case study methodology. Before starting the interviews, the content and purpose of the interview form were explained to the pre-service teachers and it was emphasised that the information collected would be kept confidential. A total of 13 pre-service teachers, 8 girls and 5 boys, participated in the study. The interviews were audio recorded with the permission of the participants. The interviews were conducted by the researcher in a seminar room at Van Yüzüncü Yıl University Faculty of Education in order for the participants to express their views freely in a comfortable environment. The interviews lasted an average of 20-30 minutes and were transcribed by the researcher.

Analysing the Data

In this study, the data obtained regarding the research questions were analysed using descriptive and content analysis methods. Content analysis is an objective and systematic research method in which the words in the texts are coded and summarised according to predetermined rules (Büyüköztürk et al., 2016a). In this method, different types of data such as interviews, observations or documents are analysed in certain stages (Demirci & Köseli, 2017). According to Yıldırım and Şimşek (2021), content analysis consists of three main stages:

Coding the Data: At this stage, the researcher determines the meaningful units in the text and assigns a code to each of them. Codes should be created in accordance with the research questions and the analysis framework.

Creating Themes: The coded data are organised into themes by considering the relationships and similarities between them. Themes represent the basic concepts and categories related to the research topic.

Interpretation of the Findings: The themes are interpreted in the context of the research questions and meaningful inferences about the findings are obtained.

In the data analysis process in this study, firstly, the interview form and the audio-recorded data were transcribed. The transcribed data were read repeatedly and each meaningful unit was assigned a code by the researcher. The codes were determined to reflect the views of classroom teachers on skill-based questions. A code list was formed by reading the data set three times and comparing different codes. The resulting code list was organised and the same and similar codes were brought together. Based on similar codes, themes related to the research topic were formed. In determining the codes, the research literature, the researcher's experience and the data set were taken into consideration. Examples of the codes obtained from the interviews with the participants are presented in the text.

FINDINGS

Prospective Science Teachers' Views on the Concept of "Skill-Based Question"

In this study, 13 pre-service science teachers' perspectives on skill-based questions were analysed through qualitative research method. Within the scope of the research, semi-structured interviews were conducted and the answers given by the pre-service science teachers to the questions were evaluated by frequency analysis.

Table 1. Prospective science teachers' views on the concept of "skill-based question"

Statements	f	%
Questions to develop reasoning skills	8	61,5
Questions to ensure the use of knowledge in daily life	6	46,2
Questions requiring reading comprehension and interpretation	11	84,6
Questions reflecting problems encountered in daily life	4	30,7
Questions to improve reasoning skills	9	69,2
Questions requiring high level mental skills	5	38,5
Open-ended and research-based questions	3	23,1
Questions requiring interdisciplinary work	4	30,7
Questions involving current events and real life problems	7	53,8
Questions requiring ability	2	15,4

When Table 1 is analysed, it can be seen that 84,6% of the pre-service teachers think of "concept-based questions" as "questions requiring comprehension and interpretation of what is read"; 69,2% think of "questions to develop reasoning skills"; 61,5% think of "questions to develop reasoning skills"; 53,8% think of "questions involving current events and real life problems"; 46,2% "questions that will enable the use of knowledge in daily life"; 38,5% "questions requiring high-level mental skills"; 30,7% "questions reflecting the problems encountered in daily life"; 30,7% "questions requiring interdisciplinary work"; 23,1% "open-ended and research-based questions" and 15,4% "questions requiring ability". The answers of some of the pre-service teachers regarding the question are as follows:

PT1: *Such questions encourage students to analyse and evaluate information from different perspectives instead of just memorising it. In this way, students have the opportunity to solve complex problems and develop their critical thinking skills.*

PT2: *Questions related to daily life increase students' motivation and interest in learning. Also, through such questions, students can see how important science is in daily life and how it is used in many fields.*

PT5: *Such questions help students to improve their reading skills and their ability to interpret texts. It also helps them gain the skills of obtaining information from different sources and synthesising them.*

PT9: *Questions involving daily life problems help students to associate science with daily life. In this way, students realise that science is not only theory and directly affects our daily lives.*

PT12: *Skill-based questions are interdisciplinary questions that help students see the connections between different disciplines and gain a holistic perspective. In this way, students can address and solve problems from different disciplinary perspectives.*

PT13: *These types of questions help students develop higher level mental skills such as analysing, synthesising and evaluating. It also encourages students' creative thinking and problem solving abilities.*

The frequency and percentage distributions of the responses of science teachers to the question "What are your opinions about the place of skill-based questions in science and mathematics education?" are presented in Table 2.

Table 2. Pre-service science teachers' views on "the place of skill-based questions in science and mathematics education"

Statements	f	%
It enables students to make sense of knowledge	7	53,8
Enables students to make logical inferences by interpreting information	11	84,6
Enables the use of knowledge in daily life	10	76,9
Develops high-level cognitive skills	6	46,2
Produces creative solutions by using knowledge	8	61,5
Prevents memorisation of information	4	30,8
It enables students to actively participate in the learning process	12	92,3
Skill-based questions are very challenging for students and are not suitable for all students.	4	30,8
Skill-based questions alone are not sufficient in science and maths lessons	1	7,7

When Table 2 is analysed, it is seen that 92,3% of the pre-service teachers regarding the place of concept-based questions in science and mathematics education "enables students to actively participate in the learning process"; 84,6% of them "enables students to make logical inferences by interpreting information"; 76,9% of them "enables students to use information in daily life"; 61,5% of them "produces creative solutions by using information"; 53,8% of them stated that "it enables students to make sense of information"; 46,2% of them stated that "it develops high-level cognitive skills"; 30,8% of them stated that "it prevents memorisation of information"; 30,8% of them stated that "skill-based questions are very difficult for students and are not suitable for all students" and 7,7% of them stated that "skill-based questions are not sufficient alone in science and mathematics lessons". The answers of some of the pre-service teachers regarding the question are as follows:

PT3: *Skill-based questions enable students to understand in depth and see the relationships between concepts instead of just memorising information. In this way, students learn information in a more permanent way and can use it in daily life.*

PT4: *For example, while teaching photosynthesis, I can help students understand this subject better by asking skill-based questions that ask students not only the definition and stages of photosynthesis, but also the importance of photosynthesis for plants and living things, how photosynthesis takes place and which factors affect it.*

PT8: *For example, by asking skill-based questions that ask students to analyse the results of an experiment or interpret a scientific article, I can ensure that students can use information in different contexts and make logical inferences.*

PT10: *Skill-based questions help students to relate their knowledge to daily life and use this knowledge to solve daily problems. In this way, students realise that science is not just theory and that it directly affects our daily lives.*

PT11: *It develops students' high-level cognitive skills such as analysing, synthesising and evaluating. In this way, students can understand complex problems, produce different solutions and contribute to scientific research.*

PT12: *Skill-based questions prevent rote memorisation as they encourage students to understand and interpret information instead of just memorising it. In this way, students learn information in a more permanent way and can use it in daily life.*

The frequency and percentage distributions of the responses of science teachers to the question "Do skill-based science and mathematics questions contribute to student development?" are presented in Table 3.

Table 3. Pre-service science teachers' views on "the contribution of skill-based science and mathematics questions to student development"

Statements	f	%
Contributes to the mental development of students	8	61,5
Improves the ability to analyse information	5	38,4
Contributes to solving the problems they face in their daily lives	9	69,2
Contributes to the permanence of learning	10	76,9
Contributes to mental organisation	7	53,8
Reveals a sense of inadequacy and makes no contribution	2	15,4
It provides partial contribution such as enabling students to actively participate in the learning process.	1	7,7

When Table 3 is examined, it is seen that 76,9% of the pre-service teachers related to the contribution of concept-based science and mathematics questions to students "contributes to the permanence of learning"; 69,2% of them "contributes to solving the problems they encounter in their daily lives"; 61,5% of them "contributes to the mental development of students"; 53,8% of them "contributes to their mental organisation"; 38,4% of them "contributes to the development of their ability to analyse information"; 15,4% of them "reveals the sense of inadequacy and makes no contribution to them" and 7,7% of them "provides partial contributions such as enabling students to actively participate in the learning process". The answers of some of the pre-service teachers regarding the question are as follows:

PT1: *Yes, skill-based questions contribute significantly to the mental development of students. Thanks to these questions, students learn to think better, solve problems and analyse information.*

PT2: *Skill-based questions contribute to the retention of learning. Thanks to these questions, students can keep the information they have learnt in their minds for a longer period of time.*

PT6: *For some students, skill-based questions may be too difficult and this may create a sense of inadequacy in them. Therefore, I think that these questions are not suitable for all students.*

PT9: *I believe that skill-based questions can contribute to student development if they are used in limited number and in the right way.*

PT10: *Skill-based questions help students solve the problems they encounter in daily life. In this way, students can put the knowledge they have learnt into practice.*

PT13: *Skill-based questions are time-consuming and there may not be enough time in the syllabus. Therefore, I believe that these questions should be used in limited number.*

The frequency and percentage distributions of the responses of science teachers to the question "What do you think about the usability of skill-based questions in science and mathematics courses?" are presented in Table 4.

Table 4. Pre-service science teachers' opinions on "the usability of skill-based questions in science and mathematics courses"

Positive Opinions	**f**	**%**
Can be used to increase the retention of learning	7	53,8
Can be used to integrate knowledge into daily life	11	84,6
It can be used in the process of making sense of concepts.	4	30,8
It can be used in the development of critical thinking skills.	9	69,2
It can be used in the development of analytical thinking and comparison skills	6	46,2
Can be used to develop research and enquiry skills	8	61,5
Negative Opinions		
Difficult to use because the questions are long	3	23,1
Not suitable for the cognitive level of secondary school students	2	15,4
It is not suitable for use in the classroom because it does not appeal to all students	4	30,8
The physical equipment of the schools is not sufficient for the implementation of these questions	1	7,7
Not suitable for use due to intensive curriculum	3	23,1
Its usability is low because it makes classroom management difficult	2	15,4

When Table 4 is analysed, it is seen that pre-service teachers expressed positive and negative opinions about the usability of concept-based questions in science and mathematics courses. 84,6% of the pre-service teachers "can be used to integrate knowledge into daily life"; 69,2% of them "can be used to develop critical thinking skills"; 61,5% of them "can be used to develop research and questioning skills"; 53,8% of them "can be used to increase the retention of learning"; 46,2% of them "can be used to develop analytical thinking and comparison skills" and 30,8% of them "can be used in the process of making sense of concepts", while 30,8% of them "it is not suitable for use in the classroom because it does not appeal to all students"; 23,1% of them stated that "it is difficult to use because the questions are long"; 23,1% of them stated that “it is not suitable to use because of the intensive curriculum”; 15,4% of them stated that “it is not suitable for the cognitive levels of secondary school students”; 15,4% of them stated that “it is not suitable to use because it makes classroom management difficult” and 7,7% of them stated that “the physical equipment of schools is not sufficient for the application of these questions”. The answers of some of the pre-service teachers regarding the question are as follows:

PT3: *Skill-based questions can encourage students to apply and analyse the information they learn instead of just memorising it, and thus make the information they learn more permanent. In this way, students can use their knowledge to solve different problems and become better equipped.*

PT4: *Skill-based questions help students to associate science knowledge with daily life and concretise abstract concepts.*

PT7: *Skill-based questions can provide a deeper learning experience by enabling students to understand not only the information but also the relationships between concepts.*

PT8: *These types of questions encourage students to research and help them discover information on their own and develop their questioning skills.*

PT10: *The fact that some skill-based questions are long and complex may make it difficult for students to solve them and may prevent the completion of all questions due to exam time limitations.*

PT11: *While skill-based questions may be suitable for students with high cognitive level, they may not be suitable for the cognitive level of secondary school students. Therefore, it is important to adapt the difficulty level of the questions according to the cognitive level of the students.*

PT13: *Bazı beceri temelli soruların cevaplanması için laboratuvar veya internet gibi kaynaklara ihtiyaç duyulması, bu tür soruların tüm okullarda uygulanmasını zorlaştırabilir. Bu durum, eğitimde eşitsizliğe yol açabilir. Tüm okulların gerekli fiziksel donanıma sahip olması önemlidir.*

CONCLUSION

As a result of the interview conducted in this study in which pre-service science teachers’ views on skill-based science and mathematics questions were examined, the following results were obtained.

In this study, the definition of skill-based questions is discussed from the perspectives of pre-service science teachers, literature and researchers. The findings of the study show that pre-service science teachers define skill-based questions as questions that involve reading comprehension and interpretation, reasoning and judgement, current events and real life problems, and enable the use of knowledge in daily life. This definition is in parallel with the use of high-level skills, reasoning and analytical thinking skills emphasised in the 2023 education vision (Gürbüz Us & Ercan Güven, 2022). Pre-service teachers' definitions of skill-based questions also coincide with the findings of other researchers. Dadandı (2022) found that students characterised such questions as long and reading comprehension questions. Sanca et al. (2021), on the other hand, argued that skill-based questions should be questions consisting of daily life problems that encourage creative thinking, imagination and activating high-level mental skills rather than memorisation. Acar and Yaman (2011) defined skill-based questions as context-based questions and emphasised that such questions should focus on daily life problems. Kılcan (2021), on the other hand, defined skill-based questions as questions that include more than one acquisition and daily life and help to gain high-level skills. As a result, although the definition of skill-based questions is expressed in different ways by different stakeholders, it meets in a common denominator. This common denominator can be summarised as that skill-based questions should be designed in a way that enables students to use their higher-order cognitive skills, make connections with daily life and develop their problem-solving skills, rather than memorisation.

Within the framework of the second question of the study, pre-service teachers' views on the place of skill-based questions in science and mathematics education were analysed. The findings show that such questions encourage active participation in the learning process and contribute to the development of high-level cognitive skills such as interpreting information, logical thinking, application in daily life and generating creative solutions. The majority of pre-service teachers stated that skill-based questions transform students into active participants rather than passive listeners. This finding shows that concept-based questions have the potential to create a learning environment that puts students at the centre and encourages their active participation, unlike the traditional rote learning approach. The findings of the study also reveal that skill-based questions help students to develop higher cognitive skills rather than just transferring knowledge. A significant number of pre-service teachers believe that such questions enable students to interpret knowledge and make logical inferences (84.6%), use knowledge in daily life (76.9%) and generate creative solutions using knowledge (61.5%). These findings show that skill-based questions contribute to the development of critical thinking, problem solving and creative thinking skills, which are characterised as 21st century skills. Researchers emphasise that skill-based questions promote not only superficial knowledge acquisition but also in-depth learning and conceptual understanding. The pre-service teachers agreed with this view and stated that skill-based questions help students to make sense of knowledge and develop high-level cognitive skills. These findings show that skill-based questions have the potential to enable students to learn knowledge in a more meaningful and permanent way, unlike the traditional rote learning approach. Researchers emphasise that skill-based questions promote not only superficial knowledge acquisition but also in-depth learning and conceptual understanding (Biber et al., 2018). The pre-service teachers agreed with this view and stated that skill-based questions help students to make sense of knowledge and develop high-level cognitive skills. These findings show that skill-based questions have the potential to enable students to learn information in a more meaningful and permanent way, unlike the traditional rote learning approach. Kızkapan and Nacaroğlu (2019) stated that LGS science questions were perceived to measure high-level skills. This finding also coincides with Uzun's (2021) study. Uzun (2021) emphasised that the new generation questions are effective in developing higher-order skills in students and gaining daily life skills. Ceylan (2022) examined the views of science teachers in Sivas and found that skill-based questions contribute to the development of students' knowledge interpretation, reasoning and logic skills and are necessary in science education. Yavaşer (2024) investigated the opinions of classroom teachers on skill-based science questions and stated that such questions contribute to the development of critical thinking skills, but they also have negativities such as not being suitable for the cognitive level, time-consuming and length. Science teachers generally think that LGS science questions are aimed at measuring high-level skills and skill-based questions can contribute to student development. However, it should be emphasised that skill-based questions also have some disadvantages and these disadvantages should be taken into consideration

The majority of the pre-service teachers participating in the study stated that skill-based science and mathematics questions contributed to students' learning retention and their ability to solve problems encountered in daily life. These findings clearly demonstrate that, compared to traditional rote learning methods, skill-based questions have the potential to provide a deeper and more meaningful learning experience by making students more active. A significant number of pre-service teachers also stated that such questions contribute to students' mental development and mental organisation skills. These findings suggest that skill-based questions can help develop cognitive skills and improve students' ability to solve more complex problems. However, some pre-service teachers expressed the concern that skill-based questions may create a sense of inadequacy in students and may not contribute anything to them. It is possible to interpret the source of these concerns as the challenging nature of skill-based questions and the fact that students are not always successful in answering such questions. The findings of the study are consistent with other studies in the literature. Studies such as Yavaşer (2024), Güneş Topal (2024), Karakeçe (2021) and Ceylan (2022) have also shown that skill-based science and mathematics questions help improve students' learning retention, problem solving skills, mental development and cognitive skills.

The fourth question of the study was the opinions of pre-service teachers about the usability of skill-based questions in science and mathematics courses. The findings show that pre-service teachers think that such questions are useful in many aspects. A significant number of pre-service teachers stated that concept-based questions can contribute to integrating knowledge into daily life, developing critical thinking, research and questioning skills, increasing the retention of learning, and developing analytical thinking and comparison skills. They also stated that such questions can be used in the process of making sense of concepts. However, some pre-service teachers also expressed concerns about the use of concept-based questions. These concerns are as follows:

- They may not be suitable for use in the classroom because they do not address all students.
- It may be difficult to use because the questions are long.
- It may not be appropriate to use due to intensive curriculum.
- It may not be suitable for the cognitive level of secondary school students.
- It may make classroom management difficult.
- The physical equipment of schools may not be sufficient for the implementation of these questions.

These findings suggest that concept-based questions can be a valuable teaching tool in science and mathematics lessons, but teachers should consider some difficulties for their effective use. Teachers should take into account the different skill and proficiency levels of students when using such questions, adjust the difficulty level of the questions accordingly, and provide the necessary support. They should also be prepared for issues such as classroom management and time management. This finding is similar to the findings of Ceylan (2022), Yavaşer (2024), Güneş Topal (2024) and Karakeçe (2021).

Within the framework of the findings of the study, the following suggestions are presented:

- Skill-based questions should be prepared in accordance with the MoNE's assessment and evaluation criteria, and students' experience with these questions should be increased.
- In the study, pre-service teachers stated that skill-based questions are not suitable for the level of all students and do not appeal to all students. In this context, it is thought that taking into account the characteristics

of the class and the age period of the students while preparing the questions may be effective in solving this problem.

- In the study, it was determined that teachers stated that skill-based questions were related to reading comprehension and ability to organise information. In this context, it is thought that ensuring parent and school co-operation in order to provide students with reading habits will increase the level of students' understanding of skill-based questions.
- Organising an informative seminar for teachers on the preparation, implementation and evaluation of skill-based questions in the classroom can minimise the problems that teachers may experience in the classroom environment.

REFERENCE

Acar, B. & Yaman, M. (2011). Bağlam temelli öğrenmenin öğrencilerin ilgi ve bilgi düzeylerine etkisi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi,* 40(1), 1- 10.

Anıl, D. (2009). Uluslararası Öğrenci Başarılarını Değerlendirme Programı (PISA)'nda Türkiye'deki Öğrencilerin Fen Bilimleri Başarılarını Etkileyen Faktörler. *Eğitim ve Bilim Education and Science,* 34(152), 87–100.

Aydoğdu, M. & Tutak, T. (2017). Ortaokul 8. Sınıflara Yönelik Matematiksel Modelleme Etkinlikleri Geliştirme. *The Journal of Academic Social Science,* (54), 155-166.

Aydoğdu, M., Cevizci, A. B. & Tutak, T. (2022). Ortaokul Öğrencilerinin Problem Çözme Stratejilerini Kullanma Becerilerine Yönelik Öğretmen Görüşlerinin Belirlenmesi. *Journal of Anatolian Education Research,* 6(6), 1-14.

Aydoğdu, M., Erşen, A. N. & Tutak, T. (2014). Materyal Destekli Matematik Öğretiminin Ortaokul 6. Sınıf Öğrenci Başarısına ve Tutumuna Etkisi. *Turkish Journal of Educational Studies*, 1(3), 166-185.

Bağır, M., Karakoyun, G.Ö. & Asiltürk, E. (2022). Views of science teachers on the use of artificial intelligence in education. *International Online Journal of Educational Sciences,* 14, 1223 – 1234.

Benek İ. (2019). *Sosyobilimsel stem etkinliklerinin öğrencilerin tutumlarına ve 21. yüzyıl becerilerine etkisinin incelenmesi*. Doktora Tezi, İstanbul Üniversitesi, Cerrahpaşa Lisansüstü Eğitim Enstitüsü, İstanbul.

Büyüköztürk, Ş., Çakmak, E. K., Akgün, Ö. E., Karadeniz, Ş. & Demirel, F. (2016a). *Bilimsel Araştırma Yöntemleri*. Pegem Yayıncılık, Ankara.

Cerit, Y., Akgün, N., Yıldız, K., & Soysal, M. R. (2014). Yeni eğitim sisteminin (4+ 4+ 4) uygulanmasında yaşanan sorunlar ve çözüm önerileri (Bolu il örneği). *Eğitim Bilimleri Araştırmaları Dergisi*, 59-82.

Ceylan, G. (2022). *Beceri Temelli Fen Sorularına Yönelik Fen Bilimleri Öğretmenlerinin Görüşlerinin İncelenmesi*, Yüksek Lisans Tezi, Sivas Cumhuriyet Üniversitesi Eğitim Bilimleri Enstitüsü, Sivas.

Çelik, R., Karakoyun, G.Ö. & Asiltürk, E. (2022). *Evaluation* of Middle School 7th Grade Science Skill-Based Questions According to the Revised Bloom Taxonomy. *International Online Journal of Educational Sciences,* 14, 705-716.

Çepni, S. (2019). PISA ve TIMSS Sınavlarına öğretmenlerimizi hazırlamaya yönelik deneyimlerimiz ve yürüttüğümüz faliyetler. S. Çepni (Ed.), *PISA ve TIMSS Mantığını ve Sorularını Anlama* içinde (s.405-417). Ankara: Pegem Akademi.

Çoban, Ö., Bozkurt, S. & Kan, A. (2019). Eğitim yöneticisi 21. yy. becerileri ölçeğinin geliştirilmesi: Geçerlik ve güvenirlik çalışması. *Kastamonu Eğitim Dergisi*, 27(3), 1059-1071.

Dadandı, N. (2022). *Yeni Nesil Fen Bilimleri Sorularına Yönelik Algı Ölçeğinin Geliştirilmesi*. Yüksek Lisans Tezi, Trabzon Üniversitesi Lisansüstü Eğitim Enstitüsü, Trabzon.

Demirci, S. & Köseli, M. (2017). *Sosyal Bilimlerde Araştırma Yöntemleri*. Alfa Yayınları, İstanbul.

Güneş Topal, H. (2024). *İlkokul Matematik Dersinde Beceri Temelli Sorular: Sınıf Öğretmenlerinin Görüş ve Uygulamaları*. Yüksek Lisans Tezi, Gaziantep Üniversitesi Eğitim Bilimleri Enstitüsü, Gaziantep.

Gürbüz Us, R. & Ercan Güven, A. N. (2020). Türkçe ve Türk Kültürü Kitaplarındaki Dinleme Becerisine Yönelik Etkinliklerin İncelenmesi. *Eskişehir Osmangazi Üniversitesi Türk Dünyası Uygulama ve Araştırma Merkezi Eğitim Dergisi*, 5(2), 1-23.

İç, Ü. & Tutak, T. (2018). Correlation between Computer and Mathematical Literacy Levels of 6th Grade Students. *European Journal of Educational Research,* 7(1), 63-70.

İlhan, A. & Tutak, T. (2021). An Evaluation of SEIE, LDE, fBEtSE and HSTE by Mathematics Teachers. International Online Journal of Educational Sciences, 13(1), 182-193.,

İlhan, A., Tutak, T., İç, Ü. & Ekinci, N. (2020). Matematik Öğretmen Adaylarının Özel Öğretim Yöntemleri Dersine Yönelik Görüşlerinin İncelenmesi. *Elektronik Sosyal Bilimler Dergisi,* 19(73), 156-170.

İlhan, G. & Asiltürk, E. (2019). Fen Bilgisi Öğretmeni Adaylarının Bazı Kimya Konularında Akıl Yürütmelerinin İncelenmesi. *Bayburt Eğitim Fakültesi Dergisi,* 14, 391 – 417.

İncebacak, B.B. & Ersoy, E. (2016). 7. sınıf öğrencilerinin matematiksel muhakeme becerilerinin TIMSS'e göre analizi. *Uluslararası Sosyal Araştırmalar Dergisi,* 9(46), 474-481.

Karakeçe, B.(2021) *Ortaokul Matematik Öğretmenlerinin Beceri Temelli Sorulara İlişkin Değerlendirmeleri*, Yüksek Lisans Tezi, Gaziantep Üniversitesi Eğitim Bilimleri Enstitüsü, Gaziantep.

Karakoyun G.Ö. & Asiltürk, E. (2020a). Analysis of pre-service science teachers' heuristic reasoning processes about hydrogen bonding. *Journal of Science Learning,* 4, 50 – 60.

Karakoyun, G.Ö. & Asiltürk, E. (2020b). Fen Bilgisi Öğretmen Adaylarının Akıl Yürütme Süreçlerinde Höristiklerin Rolü: Bileşiklerin Çözünürlüklerine Göre Sıralanması. *Tarih Okulu Dergisi,* 13, 2607 – 2635.

Karakoyun G.Ö. & Asiltürk, E. (2021). The Role of Heuristics in the Reasoning Process of Pre-Service Science Teachers on the "Chemical Structure – Acidity/Basicity Relationship" Topic, *Acta Chimica Slovenica,* 68, 645 – 657.

Karakoyun G.Ö. & Asiltürk, E. (2022). The Effect of Heuristics on the Reasoning of the Pre-Service Science Teachers on the Topic of Melting and Boiling Point, *Acta Chimica Slovenica,* 69, 60 – 72.

Kaya, S. (2017). *Lise öğrencilerinin 21. yüzyıl becerilerinin öğrenci tükenmişliği ve okul bağlılığı ile ilişkisi*. Doktora Tezi, Hacettepe Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara.

Kerlinger, F. N. & Lee, H. B. (1999). *Foundations Of Behavioral Research.* Harcourt College Publishers, New York.

Kılcan, T. (2021). Yeni nesil matematik sorularına ilişkin tutum ölçeği geliştirme: geçerlik ve güvenirlik çalışması. *Anadolu Kültürel Araştırmalar Dergisi,* 5(2), 170-180.

Kızkapan, O. & Nacaroğlu, O. (2019). Fen bilimleri öğretmenlerinin merkezi sınavlara (LGS) ilişkin görüşleri. *Nevşehir Hacı Bektaş Veli Üniversitesi Sosyal Bilimler Enstitüsü Dergisi,* 9(2), 701-719.

MEB. (2013). *Ortaokul fen bilimleri dersi (5, 6, 7 ve 8. sınıflar) öğretim programı*. MEB Yayınları, Ankara.

MEB. (2019). *PISA 2018 Türkiye Ön Raporu.* MEB yayınları, Ankara.

Merriam, S. B. (2013). *Nitel Araştırma: Desen ve Uygulama İçin Bir Rehber* (3. Baskıdan Çeviri, Çeviri Editörü: S. Turan). Nobel Yayın Dağıtım, Ankara.

Milli Eğitim Bakanlığı (MEB). (2018a). Fen bilimleri dersi öğretim programı. Ankara. Erişim Adresi: https://mufredat.meb.gov.tr/Dosyalar/201812312311937- FEN%20B%C4%B0L%C4%B0MLER%C4%B0%20%C3%96%C4%9ERET%C 4%B0M%20PROGRAMI2018.pdf, Erişim Tarihi: 12.06.2024.

Partnership, (2011). Framework for 21 st century learning. Erişim Adresi: http://www.p21.org/, Erişim Tarihi: 15.06.2024.

Sanca, M., Artun, H., Bakırcı, H. & Okur, M. (2021). Ortaokul beceri temelli soruların yeniden yapılandırılmış Bloom Taksonomisine göre değerlendirilmesi. *YYÜ Eğitim Fakültesi Dergisi,* 18(1), 219-248.

Tutak, T., İlhan, A., İç, Ü. & Kılıçarslan, S. (2018). Bilgisayar Destekli Matematik Öğretiminin Matematik Öğretmen Adaylarının Öğrenme Süreçlerine Yönelik Görüşlerine Etkileri. *Journal of Turkish Studies,* 13(27), 1509-1524.

Umay, A. (2003). Matematiksel muhakeme yeteneği. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi,* 24, 234-243.

Uzun, H. (2021) *Yeni Nesil Matematik Sorularına İlişkin Ortaokul Matematik Öğretmenlerinin Yaklaşımlarının İncelenmesi,* Yüksek Lisans Tezi, Gaziantep Üniversitesi Eğitim Bilimleri Enstitüsü, Gaziantep.

Yavaşer, M. (2024). *Beceri Temelli Fen Sorularına Yönelik Sınıf Öğretmenlerinin Görüşlerinin İncelenmesi*. Yüksek Lisans Tezi, Sivas Cumhuriyet Üniversitesi Eğitim Bilimleri Enstitüsü, Sivas.

Yıldırım, A. & Şimşek, H. (2021). *Sosyal Bilimlerde Nitel Araştırma Yöntemleri*. Seçkin Yayınları, İstanbul.

THE ROLE OF MULTIPLE REPRESENTATIONS IN TEACHING MATHEMATICS

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Abstract

The importance and use of multiple representations in mathematics teaching plays a critical role in students' understanding and learning of mathematical concepts. Organizations such as NCTM and MoNE emphasize the importance of representations in understanding how students learn mathematics. Multiple representations can be of different types such as verbal, tabular, graphical, matrix, symbolic, real-life situation and concrete models. These representations help students express, problem solve, and relate mathematical ideas. Studies show that the use of different representations increases in-depth understanding and raises interest levels. The use of multiple representations in mathematics education helps to develop students' communication, reasoning and relating skills. The aim of this study is to emphasize the importance of multiple representations in mathematics teaching and to develop methods to support students' mathematical skills. Drawing from the literature, the methods and objectives of this study will be discussed in detail.

Keywords: *Multiple Representations, Mathematics Education, Representation Types*

1. Introduction

Today, mathematics education attaches importance to the use of various teaching methods and strategies for students to understand and apply complex mathematical concepts (Aydoğdu and Tutak, 2017). In this context, the use of multiple representations has the potential to enable students to gain a deeper understanding of mathematical ideas and concepts. Leading educational organizations such as the National Council of Teachers of Mathematics (NCTM, 2000) and the Ministry of National Education (MEB, 2013) point out

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the critical importance of multiple representations in mathematics teaching. These representations may include verbal explanations, tables, graphs, matrices, symbols, real-life situations and concrete models and allow students to express mathematical thoughts, solve problems and establish relationships between concepts (Aydoğdu, Erşen and Tutak, 2014).

Studies that examine in depth how students learn and understand mathematics highlight the role that multiple representations play in learning processes. Researchers such as Mayer (2003) and Adadan (2006) have documented that the use of different representations helps students better understand and learn mathematical concepts. These studies show that students' exposure to mathematical thinking in various forms enables them to make connections between concepts and thus integrate their mathematical knowledge more effectively.

However, students' ability to switch between multiple representations is of central importance in mathematics education. Studies by Kaput (1989) and Ainsworth (2006) reveal that students' ability to successfully perform transformations between different representations is a critical factor in improving mathematical understanding. This enables students to build a conceptual bridge when moving from one representation to another and thus use mathematical information more flexibly (İlhan and Tutak, 2021).

The effective use of multiple representations in mathematics teaching is vital to improve students' skills in expressing their mathematical thoughts, solving problems and associating concepts (Aydoğdu, Cevizci, and Tutak, 2022; İlhan, Tutak, İç, and Ekinci, 2020). This study was designed to emphasize the importance of multiple representations in mathematics teaching and to develop methods on how these representations can support students' mathematical understanding. This initiative aims to contribute to a better understanding and optimization of the use of multiple representations in mathematics education, in the light of information obtained from existing literature and applications.

2. Purpose of the Research

The main purpose of this study is to comprehensively examine the literature focusing on the use of multiple representations in mathematics education and to evaluate the effects of these representations on student learning and their integration into teaching practices. In particular, it is aimed to determine the role of multiple representations on students' capacity to understand mathematical concepts, develop problem-solving skills and express mathematical ideas.

3. Method of the Research

In this research, document analysis method was adopted under the qualitative research paradigm. Document analysis involves the process of systematically examining written sources in the existing literature for the purpose of the study. This method involves in-depth analysis of sources available in both print and digital media, and thus plays an important role in finding answers to research questions.

4. Studying Group

The research sample consists of articles and theses selected in accordance with predetermined criteria and located in the databases of the Council of Higher Education Thesis Center (YÖK THESIS) and the National Academic Network and Information Center (ULAKBİM). This body of work represents a comprehensive body of literature that includes a variety of perspectives and findings regarding the use of multiple representations in mathematics education.

5. Data Collection Tool

In accordance with the purpose of the research, articles and theses related to multiple representations and mathematics education were scanned in detail from YÖK TEZ and ULAKBİM databases. In this process, current and past studies on the subject were systematically examined in line with the determined keywords and criteria. The data collection process aims to increase the scope and depth of the research.

Analysis of Data

In this research, descriptive analysis method was chosen to analyze the data obtained. This method allows the data to be restructured and evaluated from different perspectives in accordance with the research problems (Şimşek and Yıldırım, 2003).

6.1. What is Representation?

Representation can be defined as showing or expressing an idea, event or object in different ways. This concept has a broad meaning that covers both a process and the result of this process. In mathematics education, in order to teach students, the concepts in a meaningful way, these concepts must be expressed or demonstrated in various ways. The methods and tools used in this process are generally called representation.

Multiple representations describe the process of expressing a mathematical concept more than once in different ways such as verbal, graphical, symbolic. This approach allows students to see the same concept from more than one perspective and thus understand it better (Prain & Waldrip, 2006). Multiple representation theory proposes several important features that support learning and understanding:

- Ability to identify different representations of mathematical ideas,
- Effectively using information presented through different representations,
- Ability to transfer information from one form of representation to another,
- Being able to establish connections between personal internal representations,
- Ability to choose appropriate representation to solve a specific problem,
- Being able to identify the strengths, weaknesses, similarities and differences of different representations of a concept (Owens & Clements, 1998).

This approach helps students understand mathematical concepts more deeply and apply their conceptual knowledge to a wide range of subjects.

In the field of mathematics education, the integration of multiple types of representations provides a rich learning experience. Each type of representation illuminates' different aspects of mathematical concepts, contributing to students' development of basic skills such as communication, association, reasoning and problem solving. Below is an overview of these types of representation:

6.1.1 Multiple Representation Types

6.1.1.1 Status Representation

This involves the verbal or written expression of an idea. For example, the situation where "Mehmet pays 6 lira for a pack of pasta and a bottle of milk he bought from the market, and 10 lira for two packs of pasta and a bottle of milk" enables students to comprehend a problem verbally. This approach gives students the opportunity to think about mathematical problems in the context of everyday situations.

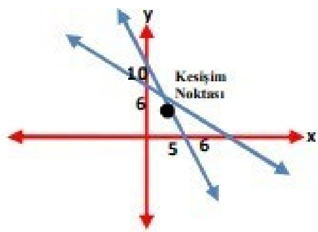
6.1.1.2 Table Representation

It is the display of the values that one or more variables can take on a table. For the equations $x+y=6$ and $2x+y=10$, an example in which y is calculated according to the values x can take and this information is put into a table, offers students the opportunity to analyze the relationship between variables in a visual format.

x+y=6 denklemi için						2x+y=10 denklemi için					
x	1	2	3	4	5	x	1	2	3	4	5
y	5	4	3	2	1	y	8	6	4	2	0

6.1.1.3 Graphical Representation

It is the expression of relationships between variables with the help of graphics. It's like determining the intersection point of two equations on a graph. This representation allows students to better understand mathematical relationships by visualizing them.



6.1.1.4 Matrix Representation

It is the expression of the set of equations in matrix form. It is especially used for solving a system of linear equations. This representation requires considering mathematical relationships at a more abstract level and offers students a different perspective.

6.1.1.5 Symbolic Representation

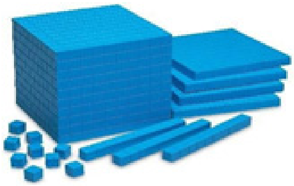
It is the expression of mathematical concepts and operations with symbols. For example, symbolic expression of a ratio such as y/x=2. This type of representation has an important role in the abstraction and generalization of mathematical thought.

6.1.1.6 Real Life Situation

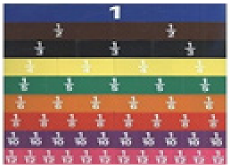
It is the application of mathematical concepts in real-world contexts. This develops students' ability to relate mathematical ideas to daily life.

6.1.1.7 Concrete Models

It involves the use of physical objects or manipulative materials. Working with materials such as fraction cards and algebra tiles gives students the opportunity to concretize abstract concepts.



Base Ten Blocks



Fraction Bars

Counting Stamps

Each of these types of representation helps students develop a comprehensive mathematical understanding by enabling them to grasp and internalize mathematical concepts from different perspectives.

6.1.1. The Importance of Multiple Representations

Multiple representations are increasingly securing their place in mathematics education. This is a remarkable development, especially in recent times, in both national and international education fields. Giving more emphasis to this approach in the development of educational programs of countries and the more intensive use of multiple representations in mathematics curricula (MEB, 2013) underline the importance of this method. Prestigious institutions such as NCTM (2000) state that mathematical understanding is closely related to individuals' capacity to express their thoughts through various representations. In this context, the use of multiple representations in mathematics education plays a central role in developing students' mathematical skills.

The use of multiple representations is of critical importance in mathematics teaching for students to have more comprehensive and understanding-based learning experiences. Educational authorities such as MEB (2013) and NCTM (2000) emphasize the role of multiple representations in teaching as follows:

Mathematical Expression and Communication: Multiple representations provide a variety of tools for students to organize, record, and communicate their mathematical thinking. This allows students to gain a deeper understanding of mathematical concepts.

Problem Solving Skills: While solving the problems presented to students, the skills of selecting, applying and transforming appropriate representations are developed. This process allows students to approach different mathematical problems from a variety of perspectives. Mathematical Modeling: Modeling of physical, social and mathematical events is done through multiple representations. This enables students to analyze real-world problems through mathematical means.

In particular, the basic skills that are aimed to be taught to students in mathematics courses include problem solving, communication, reasoning and association. The use of multiple representations supports the development of these skills while allowing students to express their mathematical ideas in a variety of formats. In mathematics lessons, students actively use representations in the process of solving the problems presented to them. This is a fundamental strategy in both understanding and solving the problem. In addition, expressing mathematical ideas with one's own thoughts, being able to use these concepts in daily life, and creating representations such as various symbols and graphics are important components of using representation. The classification made by Bingölbali and Coşkun (2016) emphasizes the various uses of multiple representations in mathematics education and the role of these uses in the development of student skills. One of the main purposes of learning mathematics is for students to be able to express their mathematical thoughts with their own thoughts, to use these concepts in daily life and to create representations such as various symbols and graphics.

The classification made by Coşkun (2016) emphasizes the various uses of multiple representations in mathematics education and the role of these uses in the development of student skills, and groups them under four main headings: association between concepts, association between multiple representations of the concept, association with daily life, and association with different disciplines. This classification shows that multiple representations not only facilitate the understanding of mathematical concepts, but also improve students' abilities to apply these concepts in a broader context. Thus, multiple representations allow students to use their mathematical knowledge effectively in their daily lives and in other disciplines, supporting the holistic learning experience that is one of the main goals of mathematics education. In this context, the effective use of multiple representations makes mathematics learning more meaningful and applicable by enabling students to understand mathematical ideas more deeply, develop critical thinking skills, and associate mathematical concepts with various situations.

6.2. The Use of Multiple Representations in Teaching Mathematics

In mathematics teaching, the integration of multiple representations offers students the opportunity to understand mathematical concepts and relationships from a variety of perspectives. The three key standards emphasized by NCTM (2000) aim to provide students with these skills, starting from pre-school period until the end of secondary education. These established standards detail the role and importance of multiple representations in learning mathematics:

Organization and Communication of Mathematical Thoughts: Organizing, recording and communicating students' mathematics-related thoughts using different representation tools plays a fundamental role in the learning process. This process allows students to process and express the concepts they learn in a personal sense.

Problem Solving with Multiple Representations: The use of various forms of representation provides students with the opportunity to gain in-depth understanding of complex mathematical concepts and problems in the process of solving them. For example, to understand the concept of fractions, graphical representations and symbols can be used as well as concrete models. This helps students develop their mathematical thinking and recognize the strengths and weaknesses of representation tools.

Modeling and Interpreting Events: Students' use of multiple representations to model physical, social, and mathematical events allows them to develop mathematical thinking skills in a real-world context. For example, materials such as pattern blocks can be used to demonstrate how to divide a certain number of objects among a group of students.

In these processes, students' abilities to express their mathematical thoughts through multiple representations, to apply mathematical concepts in daily life, and to create representations such as various symbols and graphics stand out as the basic components of representation use. The classification made by Bingölbali and Coşkun (2016) details the various uses of multiple representations in mathematics education and how these uses have a critical role in the development of student skills. In this framework, multiple representations guide students in processes such as mathematical understanding, problem solving, communication and reasoning and support the development of these skills. Teachers' role in guiding and supporting students in this process contributes to the development of their mathematical abilities by enabling students to use multiple representations effectively.

6.3. The Teacher's Role in the Use of Multiple Representations

In teaching mathematics, teachers' effective use of multiple representations plays a vital role in developing students' mathematical skills. When selecting and preparing course materials, teachers should take care to arrange the examples, problems and assignments presented to students to include multiple representation types (İç and Tutak, 2018). This approach helps students understand mathematical concepts from a variety of perspectives and establish relationships. Teachers' provision of feedback about the suitability of the representations created by students to the problem and event contexts contributes to the deepening of students' learning processes. This feedback from teachers allows students to improve their mathematical thought processes and learn from their own mistakes.

Additionally, teachers should provide students with opportunities to explore, analyze, and test mathematical relationships and hypotheses. This gives students the ability to create and test their own hypotheses, make connections between mathematical relationships, and develop problem-solving strategies. Students should be encouraged to express their thoughts through different representations in various situations and a rich learning environment should be created in this process. By sharing and discussing their work in class, students learn how to use representations effectively and how to switch between different representations.

Teachers' guidance in this process allows students to express their mathematical thoughts more effectively, develop their skills in solving complex mathematical problems, and apply mathematical concepts in their daily lives. The difficulties that students encounter in problem solving processes, the inability to choose appropriate representations, the inability to establish connections between representations, and the difficulties in integrating various representations can be overcome with the guidance of teachers. In this context, teachers' provision of the necessary support and guidance to enable students to use multiple representations effectively makes significant contributions to the deepening of students' mathematical understanding and the development of their skills (NCTM, 2000; Kılıç, 2009). This approach enriches mathematics learning and strengthens students' mathematical thinking abilities.

Result and Suggestions

This study revealed that the use of multiple representations in mathematics teaching has a critical role in improving students' understanding of mathematical concepts, association, reasoning and problem-solving skills. The standards and curriculum set by institutions such as NCTM (2000) and MEB (2013) emphasize the importance of multiple representations in mathematics education and encourage students to have richer learning experiences through these representations (Tutak, İlhan, İç and Kılıçarslan, 2018). The study showed that teachers' guidance in this process is vital for students to effectively express their mathematical thoughts and develop their skills in solving various mathematical problems.

This study emphasizes the importance of using multiple representations in mathematics education and recommends that mathematics teaching programs be strengthened to emphasize these representations more. Providing professional development programs for teachers will help them develop skills in using multiple representations effectively. Additionally, educators and researchers should conduct new research to further examine the impact of multiple representations in mathematics teaching. Students should be provided with opportunities to take active roles in the learning process and think about their own learning, and regular feedback should be provided by teachers. In addition, the integration of technology will support students in discovering, understanding and expressing mathematical concepts (İç and Tutak, 2018), which will make mathematics education more effective and meaningful. Implementing these suggestions will deepen students' mathematical understanding and provide them with the ability to express their mathematical thoughts in various ways. It is thought that emphasizing the importance of multiple representations and supporting the continuous professional development of teachers in this regard while creating educational policies can be a strategic step to achieve long-term educational goals.

References

Adadan, E. (2006). Promoting high school students' conceptual understandings of the particulate nature of matter through multiple representations. *Unpublished Doctoral Dissertation, The Ohio State University, Ohio.*

Ainsworth, S., & Van Labeke, N. (2004). Multiple forms of dynamic representation. *Learning and Instruction, 14(3), 241-255.*

Aydoğdu, M. and Tutak, T. (2017). Developing Mathematical Modeling Activities for Secondary School 8th Graders. *The Journal of Academic Social Science* (54), 155-166.

Aydoğdu, M., Cevizci, A. B. and Tutak, T. (2022). Determination of Teachers' Opinions on Secondary School Students' Skills in Using Problem Solving Strategies. *Journal of Anatolian Education Research, 6(6), 1-14.*

Aydoğdu, M., Erşen, A. N., and Tutak, T. (2014). The Effect of Material Supported Mathematics Teaching on Secondary School 6th Grade Student Achievement and Attitude. *Turkish Journal of Educational Studies, 1(3), 166-185.*

Bingölbali, E., & Coşkun, M. (2016). A conceptual framework proposal for improving the use of association skills in mathematics teaching. *Education and Science, 41(183).*

İç, Ü. ve Tutak, T. (2018). Correlation between Computer and Mathematical Literacy Levels of 6th Grade Students. *European Journal of Educational Research, 7(1),* 63-70., Doi: 10.12973/eu-jer.7.1.70

İlhan, A. ve Tutak, T. (2021). An Evaluation of SEIE, LDE, fBEtSE and HSTE by Mathematics Teachers. *International Online Journal of Educational Sciences, 13(1),* 182-193.

İlhan, A., Tutak, T., İç, Ü. and Ekinci, N. (2020). Examining the Opinions of Mathematics Teacher Candidates About the Special Teaching Methods Course. *Electronic Journal of Social Sciences, 19(73), 156-170.*

İncikabi, S. (2017). Multiple representations and mathematics teaching: a review of textbooks. *Cumhuriyet International Journal of Education, 6(1), 66.*

Kaput, J. J. (1989). Linking representations in the symbol systems of algebra. In S. Wagner & C. Kieran (Eds). Research issues in the learning and teaching of algebra (pp. 167-194). Hillsdale, NJ: LEA

Keşan, C. (2018). The effect of multiple representation-based algebra teaching on attitudes towards mathematics. *Black Sea Journal of Social Sciences, 10(18), 1-22.*

Kilic, C. (2009). *Representations used by fifth grade primary school students in solving mathematical problems* (Unpublishing Doctoral thesis, Anadolu University).

Mayer, R. E., Sims, V., & Tajika, H. (1995). A comparison of how textbooks teach mathematical problem solving in Japan and the United States. *American Educational Research Journal, 32, 443-460.*

Ministry of National Education (MEB) (2013). Secondary school mathematics course (Grades 5, 6, 7 and 8) mathematics course curriculum. Ankara.

National Council of Teachers of Mathematics (NCTM) (2000). Standarts for School Mathematics. Reston, VA: NCTM

Owens, K. D., & Clements, M. A. (1997). Representations in spatial problem solving in the classroom. *Journal of Mathematical Behavior, 17(2), 197- 218.*

Prain, V. & Waldrip, B. (2010). Representing Science Literacies: An Introduction. *Research in Science Education, 40, 1-3.*

Şimşek, H. and Yıldırım, A. (2003). *Qualitative research methods in the social sciences*. Ankara: Seçkin Publishing.

Tutak, T., İlhan, A., İç, Ü. and Kılıçarslan, S. (2018). The Effects of Computer Aided Mathematics Teaching on Pre-service Mathematics Teachers' Views on Learning Processes. *Journal of Turkish Studies, 13(27), 1509-1524.*

Ünlü, M. (2020). *New Approaches in Teaching Mathematics with Application Examples*. Ankara: Pegem Akademi.

TECHNOLOGY USAGE METHODS AND EFFECTS IN TEACHING MATHEMATICS

Tayfun Tutak[1], Büşra Nayıroğlu[2]

Abstract

The aim of this study is to comprehensively examine the current approaches to the use of technology in mathematics education and the effects of this usage on student success. In today's world, where educational processes are continuously evolving, it is imperative to adapt to the pace of technological advancements. In this context, the role of technology becomes crucial, especially in a subject like mathematics where understanding abstract concepts can be challenging. The research was conducted through a detailed literature review and the use of qualitative methods. These methods focused on how technology can make a difference in mathematics teaching, how it can help students better grasp topics, and how abstract concepts can be made more tangible. Additionally, the study discusses how educators and education policies can adapt to technological advancements and update teaching methods. This study aims to contribute to the development of strategies for the use of technology in mathematics education and to guide educators and policymakers.

Keywords*: Mathematics Education, Use of Technology, Innovation in Education, Student Success, Teaching Abstract Concepts*

Introduction

The critical role that technology plays in the progress of civilizations has gained a unique place in today's education systems, along with the development of information and communication technologies. Technology integrated into mathematics teaching has increased both the quantity and quality of teaching materials (Tutak, İlhan, İç and Kılıçarslan, 2018), thus providing significant support to students in acquiring basic skills such as thinking, reasoning,

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predicting and problem solving (Aydoğdu, Cevizci and Tutak, 2022; Ertürk, 2008; Ministry of Education, 2013).

The necessity of the integration of technology, especially in mathematics teaching, is emphasized in many international education policies. Studies such as İç and Tutak (2018), NCTM (2000) and Brophy, Klein, Postmare and Rogers (2008) indicate the critical role that technology plays in mathematics learning and the need to bring mathematics and technology together. Geometry is a basic branch of mathematics that affects many fields from art to architecture and enables us to understand the outside world. It helps students understand complex concepts by providing visualization power in fields such as geometry, algebra, arithmetic, statistics and analysis (Köse, Tanışlı, Erdoğan, & Ada, 2012; Napitupulu, 2001). Developing technology enables mathematics and geometry to be taught in interactive environments, allowing students to transfer their knowledge and skills to their daily lives more effectively.

With technological developments, the importance of mathematical literacy has increased, and mathematical literacy is defined as the capacity of the individual to use mathematical thinking and decision-making processes to solve the problems he encounters in real life (OECD, 2006; Uysal and Yenilmez, 2011). This provides students with the role of mathematics in the modern world and the ability to think numerically and spatially in applications in daily life (Aydoğdu and Tutak, 2017; Özgen and Bindak, 2008).

It is seen that technology-supported mathematics teaching enables students to participate more actively in lessons and helps them transfer their knowledge and skills to their daily lives more efficiently. However, more research is needed on the feasibility and effectiveness of these learning environments. This interaction between technology and mathematical literacy paves the way for the development of innovative approaches in education (Baki, 2002). In this context, future studies are expected to conduct more in-depth investigations into how students' spatial abilities and understanding of mathematical concepts can be improved.

In this process, the focus should be on how technology-supported educational tools can more effectively develop students' spatial abilities and mathematical thinking skills. For example, the use of dynamic geometry software can offer students new ways to explore and understand geometric concepts (Jackiw, 2001; Clements and Sarama, 2001). Additionally, such technologies can make the learning process more interesting by providing students with more freedom to solve mathematical problems and create their own solutions (Hollebrands, 2003; Olkun, Altun, & Smith, 2005).

Today, students' skills in using technology and the quality of the educational materials offered to them play a critical role in the success of mathematics education. Technology not only offers new learning methods in mathematics teaching, but also provides rich and interactive environments that will help students develop mathematical thinking and problem-solving skills (Chan Tsai and Huang, 2006; Laborde, 2001). In this context, educational technologies need to be designed and used in a way that will deepen students' understanding of mathematical concepts and enable them to apply them more effectively.

The importance of using technology in education is not limited to its potential to transform students' mathematics learning experiences. At the same time, it can positively affect students' attitudes towards mathematics and technology, increasing their interest and motivation in these fields (Uysal and Yenilmez, 2011; OECD, 2006). Therefore, technology-supported mathematics education can increase students' mathematics achievement in the long term by enabling them to be more active and motivated in the mathematics learning process.

As a result, educators and education policies should take important steps to improve both students' mathematical skills and attitudes towards this field by closely following technological developments and integrating these developments into mathematics teaching. In this process, designing and using educational technologies in a student-centered, interactive way that supports students' mathematical thinking and problem-solving skills should be one of the main goals of today's education systems (NCTM, 2000; Baki, 2002; Jackiw, 2001; Clements and Sarama, 2001; Hollebrands, 2003; Olkun, Altun and Smith, 2006; Laborde, 2011; OECD, 2006).

Purpose of the Research

The main purpose of this study is to thoroughly examine the existing literature on the use of technology in mathematics education. The study will specifically focus on how technological tools and applications can increase students' interest in learning mathematics, strengthen their motivation and improve their learning processes. It also aims to develop strategies on how to effectively integrate technological tools in the field of mathematics education and to discuss the potential benefits and challenges of these tools. This study aims to determine the role of technology-supported mathematics education in education systems and to guide educators and policy makers on this issue.

Research Method

This study uses the document analysis model, one of the qualitative research methods. Document analysis involves a systematic review of existing written materials on a targeted topic and, in this study, plays a critical role in accessing data on the use of technology in mathematics education.

Studying group

The sample of the research consists of articles, these and other academic publications selected in accordance with the determined selection criteria. In these studies, issues such as the effects of technology use in mathematics education on student success, motivation and learning experiences were discussed. The selected literature aims to develop an in-depth understanding of the impact of technology integration on student learning processes.

Data collection tool

In accordance with the purpose of the research, an extensive literature review was carried out. During this process, publications examining various aspects of technology use in mathematics education and providing information on its effects on student success, motivation and general learning experiences were examined in detail. The selected documents comprehensively discuss current research trends on the subject, application examples and the potential impacts of these applications, thus providing a rich source of data to answer research questions. The data collection process was carefully planned for the reliability and validity of the research, so that the results obtained can make significant contributions to the field of technology-supported mathematics education.

Technology in Mathematics Education

Technological advances have played a critical role in the transformation of educational sciences over the last century, a transformation that has encouraged educators to seek new avenues of research and development. In this process, technology education and how education affects technology has become an important topic of discussion. It is now generally accepted that a teaching approach that is not integrated with technology negatively affects students' success. In this context, computers and other technological tools have become indispensable elements in education. As stated by Aktümen and Kaçar (2003), educational technology is no longer limited to simple tools used in the classroom environment, but has spread to a wide range as an interdisciplinary field. The integration of technology in education requires many factors such as education, teaching methods, school environments and equipment, teachers and students to be considered together and support each other. The relationship between these factors forms the basis of an educational approach that aims to raise individuals who can learn to learn, use information effectively and have analytical thinking skills.

Approaches to mathematics education differ depending on whether mathematization exists or not, as Treffers (Hadi, 2002) points out. Treffers examined mathematics teaching under four main headings, and this classification was further detailed by Freudenthal.

1. Mechanical (Traditional) Approach: Treffers emphasizes that both horizontal and vertical mathematization are missing in this approach. The mechanistic approach is essentially algorithmic and generally relies on teaching rules and procedures. This method emphasizes the direct transfer of information and the application of rules.

2. Experimental (Empiricistic) Approach: This approach is based on students working with materials they obtain from their environment. While horizontal mathematization is used in this process, students learn concepts by working with materials. However, in the experimental approach, students generally do not tend to reach the formal level, so vertical mathematization is not used in this approach.

3. Constructivist Approach: This approach is based on theory building and aims to create a completely artificial learning environment by isolating students from the real world. Operations and structures are concretized with artificial materials to make it easier for students to understand the lesson (Aydoğdu, Erşen, & Tutak, 2014). In this approach, vertical mathematization is prominent, but does not occur unless students are provided with adequate support to develop their own methodologies.

The rise of technology in the field of education has brought a new breath to mathematics teaching methodologies. Bloom's taxonomy, in particular, stands out as a critical building block that allows us to understand the learning process more deeply. The knowledge, comprehension, application, analysis, synthesis and evaluation steps determined by Bloom aim to help students in mathematics education go beyond just memorizing information, to understand, apply, analyze and synthesize this information with new information. This process offers students the opportunity to explore mathematics actively rather than passively, in line with Hans Freudenthal's principle that "mathematics is a human activity".

Freudenthal emphasizes that the process of discovering mathematics should be guided by students and provided with opportunities for them to learn on their own. This approach is associated with De Lange's Van Hiele levels, describing the learning process as a three-stage progression: first, students make progress when they begin to use a familiar model, then when they learn the relationships between features, and finally when they understand the deeper properties of these relationships.

Within this pedagogical framework, the use of technology opens new and effective ways of learning in mathematics education. Technology helps teachers by ensuring that conceptual and procedural knowledge is better understood by students. Teaching mathematics allows students to concretize and internalize mathematical concepts through pre-planned technology-supported lessons.

However, there are important points to be considered in terms of content, method and tools used in the development of mathematics curriculum. Situations that are frequently encountered in traditional education, where the teacher constantly conveys information and the students are passive listeners, are still common in some countries, especially in Turkey. The use of technology can change this situation and enable students to participate more actively in the learning process. Integration of technology in mathematics education requires multifaceted analysis and continuous improvement of curriculum. Along with the development of programs, clustering of concepts, and organization of content at the grade level, the use of technology in teaching provides students with a rich environment to develop mathematical thinking skills. In this process, the use of technology in education enables mathematics teaching to evolve beyond just transferring information to an approach that encourages students to understand mathematics, apply it and connect with new information.

Today's educational philosophy and practices have moved beyond traditional teaching approaches that passively convey knowledge to students. Education has become much more dynamic, interactive and student-centered, especially in disciplines such as mathematics. This change aims to ensure that students understand this information, apply it, and importantly, use it in different contexts such as daily life and business, rather than just memorizing information. In this way, students can explore the relationships between fields such as mathematics and art and see the aesthetic and practical applications of mathematics. For example, the repetition, translation, and transformation of geometric shapes in a rug pattern enable students to see and understand mathematics in the world around them.

Technology is one of the cornerstones of this new understanding of education. The integration of technology in mathematics education provides students with concrete and experiential learning experiences, which then helps them successfully understand more abstract and symbolic mathematical concepts. Technology makes it easier for students to define mathematical problems and understand relationships and the dynamic changes of these relationships. Technology-supported instruction can individualize learning processes and make education more effective overall.

Technological developments in the last century have also manifested themselves in the field of education and have encouraged teachers and educators to conduct new research and development studies. The role of technology in education now stands before us as an undeniable fact. Educational technology has gone beyond the simple tools and equipment used in the classroom and has spread to a wide area covering educational environments, teaching methods and interdisciplinary studies.

In this process of change, it has become necessary to constantly re-evaluate, update and develop mathematics curriculum. The integration of technology in education has had positive effects not only on providing students with mathematical knowledge and skills, but also on their ability to use this knowledge creatively and critically. Therefore, it is of great importance for educators and policy makers to increase investments in educational technologies, keep curriculum up-to-date, and ensure that students acquire the necessary skills to be successful in a changing world.

Result and Suggestions

The use of technology in education has become a necessity rather than an obligation, especially in the field of mathematics education. Technology positively affects mathematics education in terms of both teaching and learning strategies and the content of education by creating dynamic and visual learning environments. In mathematics education, using technology in creating conceptual and procedural knowledge in students' minds provides significant convenience to teachers. In this context, technology-supported lessons make it easier for teachers to teach mathematical concepts and for students to concretize these concepts.

There is a general perception in society that learning and teaching mathematics is difficult (İlhan, Tutak, İç, and Ekinci, 2020). This perception leads to the formation of a prejudice, especially among students, such as "I cannot do this course". However, the basis of this prejudice lies in the inability to reconcile mathematics with daily life rather than the difficulty of mathematics. Technologies used in mathematics education have an important role in breaking this perception, associating mathematics with daily life and thus making mathematics more understandable.

The application of technology enhances a concrete and experiential approach to mathematical topics, providing students with the necessary foundation to succeed in understanding more abstract and symbolic mathematical concepts in later periods. Technology-supported teaching offers students individual learning experiences and allows them to solve complex mathematical problems by associating them with daily life. In this context, research shows that technology provides significant advantages in mathematics education. Studies by Taş and Yavuz (2023) and Danış et al. (2023) reveal that technology increases students' interest and motivation in lessons and supports the learning process. Another study by İnce (2023) states that visualized mathematics topics are effective in keeping students' interest alive.

Considering the impact of technology on mathematics education, it is recommended that educators effectively integrate technology into their lessons. The selection and use of technological tools should suit students' learning styles and needs. In addition, it is important that mathematics education programs are constantly reviewed and updated in accordance with technological developments. To overcome prejudices in mathematics education, the relationship of mathematics with daily life needs to be emphasized. Showing students that mathematics is understandable and accessible by offering practical applications of mathematical concepts can increase learning motivation.

Finally, investments that will increase educators' and students' access to technology will increase the quality of mathematics education and improve students' mathematical thinking and problem-solving skills. This will positively affect both students' academic success and their general attitude towards mathematics education.

References

Alkan, C. (1995). *Educational Technology*, Atilla Bookstore, 4th Edition, Ankara.

Altun, M., (2002). *Teaching Mathematics*. 10th Edition Alfa Basım Publishing Distribution, Istanbul. 399.

Aydin, C. H., and McIsaac, M. S. (2004). The Impact of Instructional Technology in Turkey.

Aydoğdu, M. and Tutak, T. (2017). Developing Mathematical Modeling Activities for Secondary School 8th Graders. *The Journal of Academic Social Science (54), 155-166.*

Aydoğdu, M., Cevizci, A. B. and Tutak, T. (2022). Determination of Teachers' Opinions on Secondary School Students' Skills in Using Problem Solving Strategies. *Journal of Anatolian Education Research, 6(6), 1-14.*

Aydoğdu, M., Erşen, A. N., and Tutak, T. (2014). The Effect of Material Supported Mathematics Teaching on Secondary School 6th Grade Student Achievement and Attitude. *Turkish Journal of Educational Studies, 1(3), 166-185.*

Baki, A. (2001). The role of technology in teaching mathematics. *Education and Science, 26(120), 3-12.*

Baki, A. (2001). *Mathematics education and technology: Integration and effects on student achievement*. Ankara: Pegem Akademi.

Brophy, J., Klein, S., Portsmore, M., & Rogers, C. (2008). Advancing engineering education in P-12 classrooms. *Journal of Engineering Education, 97(3), 369-387.*

Brophy, J., Klein, S., Portsmore, M., & Rogers, C. (2008). Mathematics and technology: Integrated approaches. *Journal of Mathematics Education, 9(1), 45-60.*

Chan Tsai, C., & Huang, C. (2006). Re-examining the effects of integrating technology into mathematics teaching. *Educational Technology & Society, 9(3), 97-108.*

Clements, D. H., & Sarama, J. (2001). An experimental evaluation of the effects of a research-based preschool mathematics curriculum. *American Educational Research Journal, 38(2), 249-274.*

Danış, F., Özkal, H., Öncü, M. A., Geçitli, F., Gergin, S., Adıyaman, S., Solmaz, M. and Durak, M. (2023). The effects of educational technologies and interactive whiteboards on learning environments. *International Journal of Social Humanities Sciences Research, 10(97), 1599-1611.*

Ersoy, Y. (2003). Socioeconomic importance of mathematical literacy. *Journal of Social Sciences, 7(2), 134-145.*

Ertürk, S. (2008). The place of information and communication technologies in education. *Journal of New Educational Technologies, 4(2), 88-97.*

Ertürk, S. (2008). A review on the use of technology in education and student success. *Education and Science, 33(150), 74-85.*

Hollebrands, K. (2003). High school students' understandings of geometric transformations in the context of a technological environment. *Journal of Mathematical Behavior, 22(1), 55-72.*

İç, Ü. and Tutak, T. (2018). Correlation between Computer and Mathematical Literacy Levels of 6th Grade Students. *European Journal of Educational Research, 7(1), 63-70., Doi: 10.12973/eu-jer.7.1.70*

İlhan, A. and Tutak, T. (2021). An Evaluation of SEIE, LDE, fBEtSE and HSTE by Mathematics Teachers. *International Online Journal of Educational Sciences, 13(1), 182-193.*

İlhan, A., Tutak, T., İç, Ü. and Ekinci, N. (2020). Examining the Opinions of Mathematics Teacher Candidates About the Special Teaching Methods Course. *Electronic Journal of Social Sciences, 19(73), 156-170.*

İnce, Ö. (2023). *Application of the instructional design organized with augmented reality in teaching the subject of geometric objects in the 6th grade* (Unpublishing Doctoral thesis).

Istanbul: Values Education Center Publications.

Jackiw, N. (2001). *The Geometer's Sketchpad* [Computer software]. Emeryville, CA: Key Curriculum Press.

Köse, N., Tanışlı, D., Erdoğan, A., & Ada, S. (2012). The place of geometry in art and architecture. *Journal of Art and Design*, 10(3), 213-229.

Köse, N., Tanışlı, D., Erdoğan, T., & Ada, S. (2012). Geometry in nature and art. *Science and Education, 21(6), 941-966.*

Laborde, C. (2001). Integration of technology in the design of geometry tasks with Cabri-geometry. *International Journal of Computers for Mathematical Learning, 6(3), 283-317.*

MEB. (2013). *Mathematics course curriculum* (Primary and Secondary School Grades 1-8). Ankara: Ministry of National Education.

Ministry of Education. (2013). *Use of technology in education*. Ankara: MEB Publications.

Napitupulu, E. (2001). Enhancing the understanding of basic geometric concepts by using dynamic geometry software. *International Electronic Journal of Mathematics Education, 6(2), 83-90.*

Napitupulu, E. (2001). Visualization in teaching geometry. *Journal of Mathematics Teaching, 5(1), 32-47.*

National Council of Teachers of Mathematics. (2000). Use of technology in mathematics teaching. *Research in Mathematics Education, 8(2), 154-168.*

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

OECD. (2006). Assessing scientific, reading and mathematical literacy: A framework for PISA 2006. Paris: Organization for Economic Co-operation and Development.

Oğuz, O., Oktay, A. and Ayhan, H., (2004), Education and Turkish Education System in the 21st Century,

Olkun, S., Altun, A., & Smith, G. (2005). Computers and 2D geometric learning of Turkish fourth and fifth graders. *British Journal of Educational Technology, 36(2), 317-326.*

Organization for Economic Co-operation and Development. (2006). *Mathematics literacy*. Paris: OECD Publishing.

Özgen, K., & Bindak, R. (2008). The effect of computer-assisted mathematics teaching on the mathematics achievement and attitude towards mathematics of 5th grade primary school students. *Uludağ University Faculty of Education Journal, 21(2), 295-308.*

Özgen, K., & Bindak, R. (2008). Mathematics literacy and its importance. *Journal of Educational Research, 8(3), 91-104.*

Taş, S., and Yavuz, A. (2023). Evaluation of geohepta mobile application-based instructions' impacts on affective behaviors. *Marmara University Atatürk Faculty of Education Journal of Educational Sciences, 57, 168-186. https://doi.org/10.15285/maruaebd.1158744*

Tutak, T., İlhan, A., İç, Ü. and Kılıçarslan, S. (2018). The Effects of Computer Aided Mathematics Teaching on Pre-service Mathematics Teachers' Views on Learning Processes. *Journal of Turkish Studies, 13(27), 1509-1524., Doi: 10.7827/TurkishStudies.14341*

Umay, A. (2003). Thinking and problem solving skills in mathematics education. *Journal of Educational Sciences, 3(1), 25-33.*

Uysal, H., & Yenilmez, K. (2011). Effects of technology use in mathematics education on student achievement: Meta-analysis study. *Educational Sciences in Theory and Practice, 11(3), 1561-1583.*

Uysal, H., & Yenilmez, K. (2011). Effects of technology on mathematical literacy. *Journal of Science and Technology Education, 1(1), 1-13.*

A STUDY ON MISCONCEPTIONS AND REASONS IN TEACHING PROBABILITY IN SECONDARY SCHOOL MATHEMATICS EDUCATION

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Abstract

This study aims to examine in detail the misconceptions encountered during the teaching of probability in 8th grade mathematics education and the reasons underlying these misconceptions. The research addresses the relationship between common errors and misconceptions in mathematics teaching, and in this context, determines the difficulties students encounter while learning the subject of probability and the reasons for these difficulties. The study was carried out by literature review method and offers solutions on how to correct the errors and misconceptions encountered in mathematics education. These recommendations focus on strategies developed to improve teaching methods and enable students to understand the subject more effectively. The research is expected to fill an important gap in the field of mathematics education and contribute to teaching practice.

Key Words: Secondary School Mathematics Education, Teaching Probability, Misconceptions, Mistakes in Education

1. Introduction

Today, mathematics is not only seen as a collection of abstract concepts, but is gaining importance as a basic tool in solving problems encountered in daily and business life. As Santos (1998) stated, the need of our age is individuals who can understand and apply mathematics. Mathematics education has a critical role in raising individuals needed by the information society who can solve problems, think independently, make decisions, express their thoughts, communicate and make data-based predictions. As emphasized by Tural

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(2005), mathematics teaching should be a course that should be constantly questioned, evaluated and improved, and should be taken seriously in all its dimensions.

The purpose of teaching mathematics can be summarized as helping individuals solve the problems they encounter in daily life, handling events from a problem-solving perspective, and providing basic mathematical skills. Geometric structures and objects used around people require mathematical thinking and basic mathematical skills. These skills are used in many areas of daily life, from understanding numerical data and graphs to making comparisons.

Concepts play a fundamental role in how individuals make sense of the world. Turkish Language Association (2010) defines the concept as general designs that include the common features of objects or events. Researchers such as Akuysal (2007) and Doğanay (2003) also state that concepts are abstract structures formed in the mind when grouped according to similar features. This grouping process is an ability of the human mind that develops through experience, and conceptual thinking is of critical importance in understanding and producing solutions to various situations encountered in daily life.

This study aims to deeply examine the misconceptions encountered during the teaching of probability in mathematics education, especially at the 8th grade level, and the reasons underlying these misconceptions. The research will examine in detail the errors frequently encountered in mathematics teaching and the relationship between these errors and misconceptions, and will analyze the difficulties students encounter while learning the subject of probability and the reasons for these difficulties. In addition, it aims to contribute to the improvement of teaching methods and the development of strategies that will enable students to better understand the subject by providing suggestions on how to correct such errors and misconceptions encountered in mathematics education.

2. Purpose of the Research

The aim of this study is to examine the misconceptions encountered by students in 8th grade mathematics education, especially during the teaching of probability, and the underlying reasons for these misconceptions in the light of the literature. It is aimed to examine in detail the relationship between common errors and misconceptions in mathematics education and to determine the effects of these errors on students' mathematical thinking skills. In addition, the aims of the study are to develop suggestions on how to correct these misconceptions and errors and to contribute to the improvement of mathematics teaching methods.

3. Method of Research

This research examines in depth the existing studies on teaching the subject of probability in 8th grade mathematics education, using the literature review method. The research aims to determine the misconceptions encountered in mathematics education, the reasons for these misconceptions, and the effects of mistakes made in mathematics teaching on student success. In this process, the effects of misconceptions and errors on students' skills such as problem solving, independent thinking, decision making, explaining their thoughts, communicating and making data-based predictions were examined. The research also aims to develop suggestions for solving these problems encountered in mathematics education and to discuss how teaching methods can be improved.

4. Studying Group

The sample of this study consists of academic theses and articles examining misconceptions and the reasons for these misconceptions, especially regarding the teaching of probability in 8th grade mathematics education. These studies, selected according to the determined criteria, focused on teaching probability and the misconceptions encountered in this process. During the selection process, studies addressing issues such as practices for teaching the subject of probability, student misconceptions and the reasons for these misconceptions were prioritized.

5. Data Collection Tool

In accordance with the purpose of the research, articles and theses containing information about misconceptions about teaching probability in 8th grade mathematics education and the reasons for these misconceptions were comprehensively scanned in academic databases. The scanning process was carried out using keywords such as probability teaching, misconceptions in mathematics education, student errors and teaching methods. In this process, current and past literature on the subject was systematically examined and the findings were compiled to form the framework of the research. These studies were used as data collection tools that formed the basis of the research.

6.1. Misconception

The concept is defined by Küçük and Demir (2009) as an abstract and general name that carries certain common characteristics of objects or events and is collected under these commonalities. For example, terms such as angle, triangle, surface and process can be given. Mistakes are behaviors that an individual develops as a result of faulty learning or experiences.

According to Gilbert, Osborne and Fensham (1982), misconceptions arise as a result of incorrect or incomplete learning of a subject and are logical for students and are settled in their minds. This situation negatively affects students' subsequent learning. For an effective teaching process, students' misconceptions should be identified and lesson planning and implementation should be done accordingly. According to Vosniadou (2002), misconceptions are students' incorrect conceptualizations that conflict with scientific knowledge and lead to systematic errors. Although misconceptions are confused with frequently made mistakes, when an error is corrected, the student does not repeat the same mistake, whereas in misconception, the student persistently continues the same wrong thought. Fisher (1985) noted some common features of misconceptions: they can be seen in many people, they can create alternative beliefs, they are difficult to overcome with traditional learning methods, and they are sometimes based on the person's past experiences.

According to Anıl (2007), the reasons why students develop misconceptions include students' inability to use their prior knowledge effectively in new learning situations, teachers' failure to provide conceptual change, failure to ensure semantic integrity in learned concepts, incomplete information, excess of foreign words in the subject, and textbooks. It can be said that the teacher effect is negative.

A three-stage process is recommended in studies to eliminate students' misconceptions. According to Gönen and Akgün (2005), in the first stage, students' knowledge deficiencies and misconceptions are determined. In the second stage, appropriate methods and techniques are developed to eliminate these misconceptions and deficiencies. In the final stage, these methods and techniques are applied to eliminate knowledge deficiencies and misconceptions.

6.2. Characteristics of Misconceptions

Misconceptions are situations that occur during the learning process and lead to incorrect or incomplete conceptualizations in individuals' knowledge structures. The features stated by Fisher (1985) are:

- Diversity: Misconceptions can occur in different forms and on various topics.
- Alternative Beliefs: Misconceptions can cause non-scientific alternative beliefs to form in individuals.
- Persistence: Many misconceptions are persistent misconceptions that are difficult to correct with traditional teaching methods.
- Experiential Origins: Some misconceptions are based on individuals' past experiences.

- Multiple Sources: Misconceptions can arise from a variety of reasons, such as biological origins, lived experiences, and educational methods.

6.3. Causes of Misconceptions

The reasons for the emergence of misconceptions are generally examined in three main categories: epistemological, psychological and pedagogical:

6.3.1. Epistemological Reasons

Misconceptions encountered in mathematics teaching may sometimes arise from the nature or characteristics of the learned concept. For example, difficulties in the historical development of concepts such as the number zero and negative numbers may be a reflection of student difficulties with these numbers. Cornu (1991) states that the historical development of a concept can give an idea about the difficulties that may be encountered in the teaching process.

6.3.2. Psychological Reasons

Psychological causes of misconceptions are related to the student's cognitive, affective and biological dimensions. Factors such as the student's comprehension ability, prior knowledge, developmental stage, and readiness level affect the way new concepts are learned. An individual's perception filter can sometimes produce misconceptions.

6.3.3. Pedagogical Reasons

Difficulties and misconceptions in learning mathematics may be due to the chosen teaching methods, materials used and pedagogical approaches. This situation is not directly related to the difficulty of mathematics or the learning capacity of students, but to how educational processes are managed.

These characteristics and causes of misconceptions can help educators and teachers better understand learning processes and develop effective teaching strategies. This information is important to correct students' misconceptions and build more solid conceptual understandings.

6.4. Types of Misconceptions

A review of the existing literature shows that misconceptions have different characteristics and therefore their types also exist. These types are defined as overgeneralization, overspecialization, mistranslation and limited conception (Graeber and Johnson, 1991; Zembat, 2008).

6.4.1. Overgeneralization

Overgeneralization is defined as the spread of a rule belonging to a certain class to other classes. For example, the fallacy that the result of multiplication is always greater than the multiplier or multiplication is one such overgeneralization. In this case, the student may apply his misconception about multiplication to other mathematical topics. An example of this type of misconception is the false belief that “the result of multiplication is always greater than the multiplier or multiplication.” With this misconception, the student may think that the result of (2/3)x(1/5) is greater than the multiplier and multiplication. This situation is an example of overgeneralization error in mathematics. These explanations are based on the work of Graeber and Johnson and discuss the types of misconceptions in detail.

6.4.2. Extreme Customization

Over specification is the situation where a particular mathematical rule, principle, or concept is valid only in a particular subclass, but is incorrectly constrained as if it were applicable to the entire class. This situation causes students to evaluate a general concept in an overly narrow framework. For example, in the context of equation solutions, when students sometimes encounter expressions such as $x^2=-2$, they assume that the equation has no roots by thinking in terms of real numbers. However, this result is valid only for real numbers; Considering complex numbers, the equation has roots. In this example, students’ conclusion that ‘the equation has no roots’ results from ignoring a broader perspective of number systems, and this is an example of the fallacy of over specification (Zembat, 2015; Bingölbali and Özmantar, 2015).

6.4.3. Mistranslation

Mistranslation is defined as systematic errors in transitions between mathematical expressions, operations, formulas, symbols, tables or graphs. Such misconceptions arise from students’ inability to interpret mathematical concepts correctly. For example, the mistaken interpretation of “divide the number 2 by 1/2” as “2/2” instead of “2÷(1/2)” results from a misunderstanding of division and related concepts. This may cause students to confuse division and multiplication operations and misjudge the relationship between the divisor and the dividend (Ma, 1999; Zembat, 2015).

6.4.4. Limited Sensing

Restricted perception is a situation where a concept is not understood broadly or deeply enough. For example, limited conceptual knowledge of fractions may prevent students from understanding and using fractions correctly. “Which of the following represents 1/3?” Students who choose an inappropriate form for a question such as this show that they have a limited perception of the concept of fractions. This occurs because students cannot fully comprehend fractions and the values they represent (Lesh, Post, & Behr, 1987; Zembat, 2015).

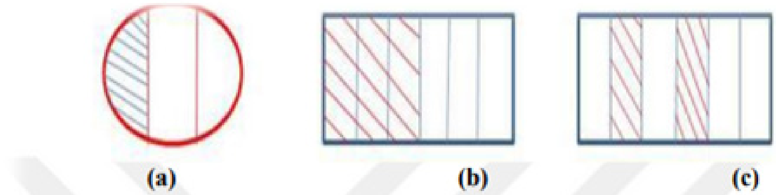

Figure 1. An example of restricted perception of fractions, example of 1/3

It is very normal for a student who perceives fraction as “dividing a whole into a certain number of parts” or “a combination of a certain number of parts” to give the above answer. If the concept of co-fragmentation is not actively used in the fragmentation process, such results are likely to occur.

6.5. Basic Misconceptions About Probability

Misconceptions encountered by students about probability in the mathematics course during education processes can negatively affect the learning process. Misconceptions about probability have been examined under three main headings as a result of detailed studies: misconceptions about the use of the concept of probability, misconceptions based on intuition, and misconceptions about the probabilities of dependent and independent events. Some specific misconceptions and related resources that fall under these categories are detailed below.

Misconceptions Regarding the Use of the Concept of Probability

- Forgetting the rule that probability values vary between 0 and 1 and cannot be greater than 1 has been stated as a mistake frequently made by students (Tunç, 2006; Gleeson, 1999).
- It is a common misconception to confuse the differences between independent events, dependent events, discrete events, and non-discrete events.
- It has been observed that the concepts of experiment and event cannot be explained clearly by students and these concepts are confused with “probability and sample space” (Yazıcı, 2002).
- Confusing the concepts of sample space and universal set is another problem that students encounter in probability calculations (Yazıcı, 2002).
- In cases such as when two dice are thrown at the same time, students’ inability to take a systematic approach in listing all the results results in the sample space not being expressed correctly (Koyuncu-Nazlıçiçek, 1998).

- In finding the probability value, it is a common misconception among students to not correctly state that the number written in the numerator is the number that comes out (Yazıcı, 2002).
- Students' difficulty in defining different events, and especially not considering the dice to land a number less than 7 in a dice-throwing experiment as a "definite event", are examples of such misconceptions (Yazıcı, 2002).
- It is a common situation that students have difficulty calculating the probability of an event not occurring and comparing the probabilities of events due to their difficulties with fractions and ratios (Tunç, 2006; Gleeson, 1999).
- Failure to understand that the conjunction "and" means intersection in sets and the conjunction "or" means union in sets is one of the difficulties faced by students (Yazıcı, 2002).

6.5.1. Misconceptions Based on Intuition

Intuition is defined as directly grasping the truth without relying on experience or reason (TDK, 2016). Some of the misconceptions experienced by students about probability are based on intuition, and these misconceptions are grouped under five subheadings: reliance on representation, positive and negative reoccurrence, the belief that the outcome in games of chance is determined by the environment or through people, the outcome approach and presence.

Reliance on Representation: People consider the sample space when making probability estimates. In a study conducted by Fischbein and Schnarch (1997), it was observed that although the probability values between the two sets of numbers chosen in the lottery game were equal, students attributed more chances to mixed numbers.

Positive and Negative Reoccurrence: Positive reoccurrence is the thought that the same outcome will occur again after successive outcomes of an event. Negative occurrence is the expectation of a different outcome after the same outcome occurs in independent events. Fischbein and Schnarch (1997) stated that if the coin lands heads repeatedly, students expect tails to appear on the next toss, which is an example of this type of mistake.

The idea that outcomes in games of chance are determined through environmental factors or people: In a study conducted by Truran (1998), it was observed that students confused the concepts of probability and chance and believed that the results of events occurred through the influence of chance (Hayat, 2009).

Consequence Approach: Individuals with a consequence approach tend to comment on the certainty of the event rather than evaluating the probability of the event. For example, when a team has an 80% probability of winning in a basketball game, thinking that this team will definitely win is an example of the outcome approach (Shaughnessy, 1993).

Presentation: Presentation is the tendency of individuals to attribute high probability to events based on their personal experiences or small sample experiences. For example, in a dice-rolling experiment, the perception of some dice combinations as more "good" or "bad" than others may result from this type of error (Amit, 1998).

6.5.2. Misconceptions about the Probabilities of Dependent and Independent Events

Misconceptions about the probabilities of dependent and independent events arise because students have difficulty understanding the difference between these two types of events. In a study by Fischbein and Schnarch (1997), an example of this type of fallacy is the incorrect assessment of the probability of certain combinations when rolling a pair of dice. In this study, participants were observed to evaluate the probabilities of getting 5-6 and 6-6 equally, which reveals misconceptions about the independence of events and correctly assessing the number of combinations.

7. Conclusion and Recommendations

The literature examining the reasons why students cannot learn probability concepts shows that this problem has a multifaceted and complex structure. This complexity arises from the existence of a number of factors that affect the students' learning process. These factors include students' readiness level, age, reasoning abilities, teacher influence, negative attitudes and misconceptions. Based on existing research, this study reveals the main factors that prevent students from learning probability concepts effectively and possible solutions to overcome these factors.

Students' level of mathematical readiness can directly affect their learning success in subjects such as probability, which require an understanding of basic mathematical concepts. For example, inadequate understanding of basic concepts such as fractions and percentage calculations may make it difficult to learn probability concepts (Gürbüz & Birgin, 2012). In this context, reinforcing students' prior knowledge and eliminating their deficiencies is seen as an important step in teaching probability. The age factor can have a significant impact on students' capacity to understand probability concepts. The study conducted by Fischbein and Schnarch (1997) revealed that students, especially in adolescence, were more successful in understanding and applying probability concepts. This finding emphasizes that teaching strategies should be designed appropriately for the age group of the students. Students' reasoning abilities and thinking styles also play an important role in learning probability concepts. Comparative studies show that the reasoning strategies students use when solving probability problems have a direct impact on their success (Jones, Langrall, Mooney & Thornton, 2004). Therefore, giving students the opportunity to use various reasoning and thinking strategies can positively affect the learning process.

The teacher's role is critical in the process of students learning probability concepts. Effective teaching methods and the teacher's mastery of the subject can ensure that students understand and are interested in the subject (Stohl & Tarr, 2002). Additionally, teachers' positive attitude and motivation can increase students' interest in probability concepts and support the learning process. Students' negative attitudes and misconceptions are other important factors that make learning probability concepts difficult. To overcome negative attitudes and misunderstandings, teachers need to develop strategies to correct misconceptions and encourage positive attitudes by interacting with students (Confrey & Maloney, 2010). As a result, students' successful learning of probability concepts is a complex process that depends on many factors. The key to success in teaching probability is for teachers to develop teaching strategies appropriate to students' needs and learning styles, taking these factors into account.

Suggestions:

- Crowded classrooms make teaching mathematics difficult. Therefore, classes should be limited to 20-25 students.
- While teaching concepts, examples from the environment where students live should be given and associated with daily life.
- Since the learning levels of the students in the class are not homogeneous, mathematics education cannot be provided in the desired quality. Therefore, classes should be made homogeneous.
- In order for our teachers to be able to implement the new program, they should receive in-service training on the applications, methods and techniques of the new program.
- Examination systems should be made according to the curriculum and questions should be asked within the framework of the subjects taught.
- Families are informed about the newly implemented system and they are also included in the education.
- The limitations of the topics and the intended objectives should be determined.

- It is beneficial for teachers to learn concepts and subjects if they do not solve the questions themselves about the topics they teach, but have students solve them and get their opinions on the questions, and help students wherever they make mistakes in problem solving.
- In mathematics teaching, emphasis should not only be placed on procedural and rule-based knowledge, but also on conceptual knowledge that forms the basis of this knowledge.
- Textbooks and supplementary books should be turned into reference books after being examined by subject area, language, program development and measurement and evaluation experts.
- In teaching mathematics, teaching should not be done through presentation using only the blackboard. Different teaching methods and technology should be used depending on the characteristics of the subjects.
- In order to increase students' interest in mathematics, a good learning environment should be prepared where they can communicate well with each other and discuss mathematics.

References

Akuysal, N. (2007). *Misconceptions of 7th grade primary school students about geometric concepts in 7th grade units* (Master's thesis). Selçuk University Institute of Science and Technology, Konya.

Ardahan, A. (1990). Mathematics teaching. *Selcuk University Faculty of Education Journal, 4th.*

Bingölbali, E. and Özmantar, M. F. (2012) "*Mathematical Misconceptions: Reasons and Search for Solutions"*, Mathematical Difficulties Encountered in Primary Education and Solution Suggestions, Edt.: Bingölbali, E. and Özmantar, M. F., Pegem Akademi: Ankara.

Bingölbali, E., Özmantar, M.F., Akkoç, H., & others. (2009). *Mathematical Misconceptions: Reasons and Search for Solutions*. Bingölbali, E. and Özmantar, M.F. (Ed.), Mathematical Difficulties Encountered in Primary Education and Solution Suggestions (pp.1-30). Ankara: Pegem Akademi.

Confrey, J., & Maloney, A. (2010). The role of the teacher in facilitating learning in mathematics and statistics. *Journal for Research in Mathematics Education*, 41(5), 398-431.

Cornu, B. (1991). Limits. In D. Tall (Ed.), *Advanced mathematical thinking* (pp. 153-166). Boston: Kluwer.

Doğanay, A. (2003). *Development of concepts and generalizations in teaching, teaching life sciences and social studies*. Ankara: Pegem Publishing.

Fischbein, E., & Schnarch, D. (1997). The evolution with age of probabilistic, intuitively based misconceptions. *Journal for Research in Mathematics Education*, 28(1), 96-105.

Fisher, K. (1985). A misconception in biology: Amino acids and translation. *Journal of Biology Education, 22, 53-62.*

Gleeson, K. (1999). Assessing Teaching and Learning of Probability within a Low to Middle Ability Year 10 Group. s13a.math.aca.mmu.ac.uk/Student_Writings/CDAE/Kieran_Gleeson.html on 17.08.2005. taken from the website

Göçük, Ş. (2019). *Determining the misconceptions of eighth grade secondary school students about exponents and radical numbers* (Master's thesis). Fırat University, Institute of Educational Sciences, Department of Mathematics and Science, Department of Mathematics Education, Elazığ.

Gürbüz, R., & Birgin, O. (2012). Pedagogical content knowledge of primary school mathematics teacher candidates regarding fractions. *Educational Sciences in Theory and Practice, 12(1), 355-366.*

Jones, G., Langrall, C., Mooney, E., & Thornton, C. A. (2004). Students' probabilistic thinking in instruction. *Journal for Research in Mathematics Education, 35(5), 329-347.*

MEB. (2009). Board of Education and Discipline primary school mathematics course curriculum and guide for grades 6-8. Ankara: Ministry of National Education.

Özdeş, H. (2013). *9th grade students' misconceptions about natural numbers* (Unpublished master's thesis). Adnan Menderes University, Institute of Social Sciences, Department of Educational Sciences, Aydın.

Stohl, H., & Tarr, J. E. (2002). Developing notions of inference with probability simulation tools. *Journal of Mathematical Behavior, 21(3), 319-337.*

Şafak, C. (2016). *Examining 8th grade students' misconceptions about probability* (Unpublished master's thesis). Abant İzzet Baysal University, Institute of Educational Sciences, Department of Primary Education, Department of Mathematics Teaching, Bolu.

Truran, K. (1998). Is It Luck, Is It Random or Does the Dice Know. The Fifth International Conference on Teaching Statistics (ICOTS 5).

Tunç, E. (2006), *Levels of Providing Knowledge and Skills on Probability to 8th Grade Students in Private Primary Schools and State Primary Schools*. master's thesis. Balıkesir University Institute of Science and Technology, Balıkesir.

Tural, H. (2005). *The effect of teaching with games and activities on achievement and attitude in primary school mathematics teaching* (Master's thesis). Dokuz Eylül University Institute of Educational Sciences, Izmir.

Vosniadou, S. (2002). On the nature of naive physics. In M. Limon & L. Mason (Eds.), Reconsidering conceptual change: Issues in theory and practice (pp. 61–76). New York: Kluwer Academic Publishers.

Yazıcı, E. (2002). *Teaching Permutation and Probability through Discovery*. Unpublished Master's Thesis, Karadeniz Technical University, Institute of Natural and Applied Sciences, OFMA Education Mathematics Education, Trabzon.

Zembat, İ. HE. (2010). "*Different Perception of Numbers – Is the Problem with Numbers, Students or Teachers*?". M.F. Özmantar, E. Bingölbali, and H. Zembat, BC. (2008). What is a misconception? (Ed.) Bingölbali, E. and Özmantar, M.F. Mathematical misconceptions and solution suggestions. 1-8. Ankara: Pegem Akademi.

Zembat, I. Ö. (2008). *Mathematical misconceptions and solution suggestions*. What is a misconception, 1-8.

FORECASTING SKILLS INCLUDED IN THE CURRICULUM PROGRAM

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Abstract

In daily life, the need to use and understand mathematics is becoming increasingly important and is constantly growing. New information and technologies are continuously changing the ways of doing mathematics and communicating. Among the objectives of the primary school mathematics curriculum is the statement, "will be able to effectively use estimation and mental computation skills." Mathematics equips individuals with the ability to solve everyday problems. They can solve problems in their minds without the need for paper, pencil, or a calculator. During mental problem solving, estimation strategies are employed. Some of these estimation strategies require operational estimation, while others require measurement-based estimation. This study discusses what estimation strategies are and how they are used by reviewing the literature.

Keywords: Estimation Strategies, Measurement-Based Estimation, Mind, Operational Estimation

Introduction

Prediction term; It refers to finding the most appropriate approximate value that can be substituted for a precise number that corresponds to a certain context alone (Van De Walle, Karp, & Williams, 2016). There are many definitions of the concept of prediction in the literature. Micklo (1999) explained the concept of estimation as the act of deciding the size of something without the actual counting and measuring process. Segovia and Castro (2009) defined it as making a decision in advance about the value of a measure or the result of a transaction without taking action. Reys (1985) described estimation as the

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process of reaching the real answer. Levine (1982) argues that the reason why the concept of prediction is important is that it is frequently used in daily life. Panhuizen (2001) stated that estimation and mental calculation skills are the skills of doing mathematics in daily life and are frequently used. The skill of estimation is widely used in daily life as well as in mathematics, and this widespread use reveals the importance of the skill of estimation (Er and Artut, 2016; Trafton 1986).

Gardner (1993) used the prediction skill in explanations of different intelligences. For example, learners with mathematical intelligence use the ability to design experiments, carry out experiments, and predict results; Learners with visual spatial intelligence can make predictions using pictures; Learners with social intelligence predict the behavior of characters. Similarly, different prediction skills have been included in the mathematics education literature. For example, transactional, metrical, and lumped estimates (Hanson & Hogan, 2000).

Until 1980, educators did not attach sufficient importance to prediction skills. However, as a result of research conducted in the 1980s and later, the importance of estimation skills began to be emphasized and curriculums began to be developed to include regular, systematic and continuous 'prediction activities' in mathematics curricula (Sowder, 1992). Educators who emphasize the importance of prediction skills (Brade, 2003; Colmer, 2006); They state that estimation skills are not only necessary for several types of professions and daily life, but also improve many mathematical abilities such as mental activities, spatial spatial visualizations, measurements and understanding numbers.

Benefits of Forecasting Skills:

NCTM (1989, 2000), in its published standards, states that estimating is an important tool for students to understand issues such as understanding numbers, performing operations with them flexibly, and discussing the meaningfulness of their answers. In addition, using the results of research, the benefits of estimation skills can be listed as follows: Teaching mathematical concepts (Lemaire, Lecacheur & Farioli, 2000; Patkin & Gazit, 2013; Siegler & Booth, 2005); developing number sense/perception (Carroll,1996); assessing students' understanding of measurement (Gooya et al., 2011); providing a general understanding of mathematical relationships (Dowker, 1992); structuring knowledge (Osborne, 2005); using skills in real life (Siegel, Goldsmith, & Madson, 1982); advancing metacognitive skills (Carroll, 1996); helping students increase motivation and get used to standard units (Van de Walle, 2004); Sharing prediction strategies allows students to understand different ways of thinking and provides a rich discussion environment in the classroom (NCTM, 2000); Making decisions about the acceptability of the answer obtained with paper-pencil calculation or calculator (Bestgen, Reys, Rybolt, & Wyatt, 1980) and teaching risk taking in mathematics, thus gaining flexibility in applying different strategies, which encourages students to find new ways. motivation (Adams, Onslow, Edmunds, Chapple, & Waters, 2005).

What is Transactional, Massive and Measurement Forecasting?

The subject of forecasting has been examined under three headings: bulk forecasting, operational forecasting and measurement forecasting (Berry, 1998; Dowker, 1992). Determining the number of multiples formed when more than one object comes together (Akkuşçi, 2019), giving the most appropriate and realistic results without making any calculations in finding the result of mathematical operations and mathematical problems (Dowker, 1997), approximating the dimensions of an object without using a measuring tool (Dowker, 1997). Determining as is defined as a measurement estimate (Budak, 2019). In the estimation skill that is frequently used in daily life, people use various shortcuts to reach the closest value to the result, and these shortcuts are referred to as estimation strategies (Van de Walle, Karp, & Bay-Williams, 2019).

According to Segovia and Castro (2009), prediction is of two types: operational prediction, which is seen as giving an answer close to the result of an arithmetic operation, and measurement prediction, which requires predicting the result by making measurements.

Estimation Skill in Curriculum:

Knowing that estimation skills have been given importance in mathematics curriculum since 1948 may contribute to teachers, teacher educators, people involved in curriculum development and book authors to give more importance to this subject and improve their own estimation skills (Bulut, Yavuz, & Yaman, 2013).

When we look at the contents of primary school mathematics curriculum regarding estimation skills, these programs implemented between 1968 and 2015 have different numbers of estimation-oriented goals and/or targets. However, target expressions containing the word “prediction” are mostly in levels 1-5. While it is included in grades 6-8, prediction is included among the problem solving skills (Yaman and Bulut, 2017).

When the 2009 and 2013 primary school mathematics curriculums, which were recently implemented or started to be implemented, were examined, it was seen that although there were prediction strategies and explanations for students to develop their own strategies, they were not reflected in the treatments in some mathematics textbooks examined (Bulut, Boz-Yaman, & Yavuz, 2016).

In the 2009 primary school mathematics curriculum, rounding, grouping, using matching numbers, using first or last digits, and distribution strategies are expected to be implemented in teaching estimation (MEB, 2009a, 2009b). Later, similar naming was used in the following 2013 program (MEB, 2013).

In MEB (2018), individuals with mathematical competence are expected to have acquired problem-solving and posing skills. Individuals who have initiative and entrepreneurship competencies are expected to have acquired skills that include predicting, comparing the prediction with the calculated result, and performing mental operations. Here too, it is seen that forecasting skill is important within the framework of competencies Er (2023).

Dimensional forecasting strategies

Using a fixed point or reference point; Students need to have a good knowledge of the reference point they will use (van de Walle, 2004). In this strategy, the object whose size is to be estimated is compared with a known (in the mind) reference size. For example, this tree is 4 times the size of the entrance (van de Walle, 2004) or the length of a football field can be visualized when estimating distances (MEB, 2009b).

Unit repetition strategy; It is the mental practice of repeatedly applying and counting units to estimate the length of an object (Hildreth, 1983). For example, when measuring the length of a blackboard, measuring with repetitive hand movements along the board is an example of this (Gooya et al., 2011). This strategy involves remembering a standard unit of the object to be estimated, such as a foot, and measuring the object to be measured in this way by repeating this unit (Joram et al., 2005).

Using prior knowledge; It is the use of the knowledge one has about the object or unit to be predicted. For example, someone who knows that the ceiling tiles are 1-foot-long and one foot is 36 cm can accurately estimate the length of the room using feet (Hildreth, 1983) or finding the height of the school using the height of the classroom they already know (Gooya et al., 2011).

Mental meter; Thinking of a meter in your mind and measuring the lengths of the objects you want to measure accordingly. For example, in estimating the length of the board, creating a mental image of 1 meter and calculating the length of the board accordingly and finding it to be 4 meters (Gooya et al., 2011).

To compare; In this strategy, the object to be predicted is compared with another object. Here, an object that the person guessing already knows is used. A person's prior knowledge is important (Hildreth, 1983). For example, when estimating the height of the tree, do not say that it is equal to the height of the school (Gooya et al., 2011).

Shredding-Stacking; subdividing the unit (Hildreth, 1983; van de Walle, 2004). For example, if the length of a room is to be estimated and there are windows and panels along that edge, this can be achieved through the lengths of the spaces between the windows, panel and window (Van de Walle, 2004).

Compression; making a prediction based on two measurements that are slightly less and slightly more than the object to be predicted (Hildreth, 1983; Gooya et al, 2011). For example, if an estimate is to be made regarding a measurement of 70 cm in length, the person making the estimate can estimate between half a meter and 1 meter (Hildreth, 1983).

Making random guesses: When making a guess with this strategy, reasons such as eye guessing or I made a guess are given (Segovia and Castro, 2009).

Transactional (Computational) Forecast:

In the 2009 primary school mathematics curriculum, rounding, grouping, using matching numbers, using first or last digits, and distribution strategies are expected to be implemented in teaching estimation (MEB, 2009a, 2009b). Later, similar naming was used in the following 2013 program (MEB, 2013).

Reys et al. (1982) stated that in their research, in addition to rounding, which is the most prominent example of this process, they identified the following subtypes:

Strategy for Arranging the Steps:

a) Using the First Digits: It is the use of the first or first two digits at the top left of the given numbers.

Example: 81419 + 92765+ 90045 + 81974 + 98102=? If the numbers in the left leading digits of the numbers in the question are added together, 8+ 9 + 9+ 8+ 9= 43 and the result of the calculation is estimated as 430000.

b) Rounding to the nearest multiple of 5, 10, 100 and so on:

This strategy is to round the given number or numbers to another number that is closest to it, easiest to perform the operation with, and is a multiple of 5, 10, 100, and performs the operation. Example: question 474257/8127; The number 474257 is rounded to 480000, the number 8127 is rounded to 8000 and becomes 480000/8000, and the result is estimated as 60.

Matching the Numbers:

a) Using Matching Numbers: In order to operate more easily with other numbers in the question, it is the use of a number that is close to the number to be changed and is suitable for operation.

Example:

(347x6)/43 The matching numbers in this question are 6 and 43. The number 43 is rounded to 42 and simplified by 6. The number 347 is rounded to 350 and 50 is found by doing 350/7.

b) Using the Equivalent of the Number: It is the use of an equivalent or approximately equivalent version of the number. Conversions can be made such as converting a fraction to a decimal or percentage.

Example: What is 30% of 106409? In the question, if 30% is taken as approximately 1/3 and the number 106409 is rounded to 105000, 1/3 of 105000 is calculated as 35000.

Reorganization of transactions:

It is the process of transforming the mathematical structure of the problem into a more useful form. This form is then used to obtain numerical data by making calculations. Reys et al. (1982) observed the following two types of this strategy in their research:

a) Changing the Order of Operations: Performing the operation by changing the order of the operations given in the question so that they are mathematically equal.

Example: In the question (347x6)/43, instead of doing the multiplication first, the easier operation 43/6 is done. 43/6 is approximately 7. Then 347/7 is estimated at approximately 50.

b) Grouping:

The process is performed by grouping the numbers in the question based on a certain value and grouping the numbers based on this value. The main thing here is to use the combination feature of addition.

Example: 87419+92765+90045+81974+98102=? Since all the numbers given in the question are close to 90000, the process is converted to 5x90000 and the result is estimated as 450000.

Editing-Correction: It is the adjustment of the changes that occur in the problem as a result of rearranging the numbers and operations, making the result obtained closer to the real result. This strategy manifested itself in two separate stages:

1) Editing-correction made at the beginning of the process: These corrections made at the beginning of the process are in the form of balancing and are related to the identifiable stages of the problem.

Example: In the operation 73655 + 86421 + 91943 + 96509 + 93421 + 106409, numbers other than 73655 are rounded to 100000. 73655 is used to round others up. So the increase in numbers is balanced by not taking the other number into account. The result is estimated at 600000.

2) Editing-correction made at the end of the process: It is the editing-correction made after the calculations are made, considering the relationship between the exact answer and the prediction. Thus, a certain amount is subtracted from or added to the initial estimate.

Example: 21 319 908/26 =? In the question, if the number 21 319 908 is rounded to 26 000 000, 26 000 000/26 = 1 000 000; but it should be less than 1 000 000, the result can be estimated at approximately 850 000.

Reys et al. (1982) stated that rearranging operations is a more flexible process than rearranging numbers. Rearranging operations involves changing both numbers and operations, while rearranging numbers involves changing only numbers.

Aim

The aim of this study is to explain what the prediction skills in the curriculum are, how teachers who want to improve these skills should behave, and what the sub-fields are.

Method

In this study, document analysis method, one of the qualitative data collection methods, was used. The document analysis method covers the processes of collecting, reviewing, taking notes and evaluating all printed and electronic resources for a specific purpose (Sak et al., 2021).

Data collection tool

In the study, the literature on collaborative learning in mathematics education was systematically scanned from YÖK TEZ and ULAKBİM databases. This process was carried out in accordance with the purpose of the research.

Analysis of Data

The collected data were examined using the document analysis method. Document analysis is a scientific research method that can be defined as the collection, review, query and analysis of various documents as the primary source of research data.

CONCLUSION

(Yaman and Bulut, 2017) Achievements, goals, behaviors and objectives show that the skill of forecasting has been emphasized in all programs in the history of our country since 1968. The main source of teachers' classroom practices is curriculum. Although it is known that implicit curricula are implemented in classrooms as well as written curricula, a teacher's knowledge of curricula has been considered within teaching content knowledge since

Shulman (1986). For this reason, teachers need to be aware of the concepts included in the curriculum and reflect these concepts into their teaching environments.

It is seen that applications related to prediction are included in the goals/behaviors or achievements, general and specific goals of the mathematics curriculum until today. This situation has required teachers to implement practices that demonstrate this importance in their classrooms since 1968. For this reason, it is worth examining whether teachers are aware of the curriculum and its content, their attitudes and thoughts about the relevant subject, and how they create learning environments on the subject in the context of their own perspectives. There are studies showing that teachers' positive attitudes are an important factor in learning a lesson (Fang, 1996; Ford 1994; Kagan, 1992; Raymond, 1997; Thompson, 1992). Therefore, what teachers think about this skill and its teaching is an important first step in teaching this skill effectively. Although many studies have been conducted on the extent to which the prediction skill is taught, how successful students are, and the types and strategies of this skill, there are not many studies examining teachers' thoughts on this subject (Tsao & Pan, 2013).

Most educators and academic experts agree on the importance of making predictions. However, teachers only make predictions about rounding in daily life. This causes students not to use other prediction strategies and to not gain flexibility, fluency and creativity. The teacher's inclusion of prediction by creating an interaction-based classroom environment in his classroom increases students' belief in themselves and their ability to do mathematics, and shows that they will have a positive attitude towards mathematics. The finding regarding the importance of prediction in daily life is consistent with Siegel, Goldsmith, and Madson (1982).

It is known that teachers' beliefs about mathematics affect students' beliefs, attitudes and even success in lessons. Therefore, one of the important results of this research is to reveal the existence of teachers' negative beliefs about prediction skills. In an environment where everything is changing frequently, rules cannot be applied for a long time, and curriculum, exam content and the way the exam is conducted are constantly changing, transactions and evaluations made with approximate values are not taken seriously by teachers (Yaman and Bulut, 2017).

Asking children questions that require prediction in the classroom environment will encourage their mathematical reasoning and intuitive mathematical abilities. Although guessing is generally based on initial thoughts using previous knowledge, it has an important function for later stages, giving children opportunities to defend or refute the ideas they uncover at the beginning of an exploration (Güven and Göncü, 2020).

It seems that studies on forecasting in Turkey are mostly aimed at secondary school students. However, based on the mathematics curriculum, the subject of prediction is taught starting from the first grade of primary school. The fact that little or no research on this subject has been conducted with students in younger age groups reveals the paucity of information about students of this age in the literature in terms of program development, textbook writing or course teaching methods. As a matter of fact, although Aslan (2011) suggested that studies on prediction skills should be carried out in first, second and third grades, no studies have been conducted in first grades in the past five years. However, in studies conducted in different countries, it is seen that the development of forecasting skills has been examined broadly at different educational levels, starting from kindergarten (Levine, 1982; Dowker, 1997; Baroody and Gatzke, 1991; Crities, 1992).

References

Adams, L., Onslow, B., Edmunds, G., Chapple, N., & Waters, J. (2005). *Children's development of range based estimation skills: far more than guess work*. In Proceedings of the third international conference on education, Honolulu, HA.

Akkusçi, H. (2019). *Examination of length measurement estimation skills of sixth and seventh grade students.* Unpublished Master's Thesis, Erzincan Binali Yıldırım University, Erzincan.

Baroody, A. J., and Gatzke, M. R. (1991). "The Estimation of Set Size By Potentially Gifte dk Kindergarten- Age Children", *Journal for Research in Mathematics Education, No. 22(1), pp. 59-68.*

Bestgen, B. J., Reys, R. E., Rybolt, J. F., & Wyatt, J. W. (1980). Effectiveness of Systematic Instruction on Attitudes and Computational Estimation Skills of Preservice Elementary Teachers. *Journal for Research in Mathematics Education, 11(2), 124-136.*

Berry, R. Q. (1998). *Computational estimation skills of eight grade students*. Unpublished Master's Thesis, Christopher Newport University, Virginia.

Brade, G. A. (2003), *The effect of a computer activity on young children's development of numerosity estimation skills*, Unpublished Doctoral dissertation, University of New York al Buflalo, New York

Budak, E. B. (2019*). Examining the impact of scripted concept cartoons on 5th and 6th grade students' measurement estimation and reflective thinking skills*. Unpublished Master's Thesis, Marmara University, Istanbul

Bulut, S., Boz-Yaman, B., & Yavuz, F. D. (2016). Evaluation of Teaching Programs on the Treatment of Transformation Geometry in 7th Grade Mathematics Textbooks. *Elementary Education Online, 15(4), 1164-1190.*

Bulut, S., Yavuz, F. D., & Yaman, B. (2017). 1-5 of Forecasting Skills from 1948 to 2015. Grades: Its Place in Mathematics Curriculum. *Ahi Evran University Kırşehir Faculty of Education Journal, 18(1), 19-39.*

Burçak, B. Y., & Bulut, S. (2017). Secondary school mathematics teachers' opinions about estimation. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education, 11(1), 48-80.*

Boyraz, D. S., & Aygün, M. (2017). Studies on Prediction in Mathematics in Turkey. *Journal of National Education, 46(216), 165-185.*

Carroll, W. (1996). Mental computation of students in a reform-based mathematics curriculum. *School Science and Mathematics, 96(6), 305-311*.

Colmer, B. (2006). Guess what...? APMC, 11(4),29-32.

Crites, Terry (1992). "Skilled and Less Skilled Estimators' Strategies for Estimating Discrete Quanti ties", *The Elementary School Journal, S. 92(5), pp.601-619*

Dowker, A. (1992). Computational estimation strategies of professional mathematicians. *Journal for Research in Mathematics Education, 23(1), 45-55.*

Er, Z. and Dinç-Artut, P. (2016). Evaluation of the estimation skill in the mathematics program in line with the opinions of mathematics teachers. *International Journal of Social Science, 52, 487-505. DOI: 10.9761/JASSS366*

Fang, Z. (1996). A review of research on teacher beliefs and practices. *Educational Research, 38(1), 47-64.*

Ford, M. I. (1994). The teachers beliefs about mathematical problem solving in the elementary school. *School Science and Mathematics, 94(6), 314-322*.

Gardner, H. (1993). *Multiple intelligences: The theory in practice*. New York: Basic books.

Gooya, Z., Khosroshahi, L. G., & Teppo, A. R. (2011). Iranian students' measurement estimation performance involving linear and area attributes of real-world objects. *ZDM Mathematics Education, 43(5), 709-722.*

Hanson, S. A., & Hogan, T. P. (2000). Computational estimation skill of college students. *Journal for Research in Mathematics Education, 31(4), 483-499*.

Hildreth, D. J. (1983). The use of strategies in estimating measurements. *Arithmetic Teacher*

Joram, E., Gabriele, A. J.,Bertheau,M.,Gelman, R.&Subrahmanyam, K. (2005). Children's use of the reference point strategy for measurement estimation. *Journal for Research in Mathematics Education, 36(1),4-23.*

Lemaire, P., Lecacheur, M., & Farioli, F. (2000). Children's strategies in computational estimation. *Canadian Journal of Experimental Psychology, 54(2), 141-148.*

Levine, D. R. (1982). Strategy use and estimation ability of college students. *Journal for Research in Mathematics Education, 13(5), 350–359. doi:10.5951/jresematheduc.13.5.0350.*

MEB. (2009a). Primary school mathematics course (1st-5th grades) curriculum.

MEB. (2009b). Primary school mathematics course (6th-8th grades) curriculum.

MEB. (2013). Secondary school mathematics course (5th, 6th, 7th and 8th grades) curriculum.

MEB. (2018) Secondary school mathematics course (5th, 6th, 7th and 8th grades) curriculum.

Micklo, S. J. (1999). Estimation it's more than a estimat. Childhood Education, 75(3), 142 145.

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

Osborne, J. (2005). *The role of argument in science education. In K*. Boersma (Ed.), Research and the Quality of Science Education (pp. 367-380). The Netherlands: Springer.

Panhuizen H. M. (2001). *Children learn mathematics: a learning-teaching trajectory.* Netherlands: Freudenthal Instıtute

Patkin, D., & Gazit, A. (2013). On roots and squares – estimation, intuition and creativity. *International Journal of Mathematical Education in Science and Technology, 44(8), 1191-1200.*

Raymond, A. M. (1997). Inconsistency between a beginning elementary school teacher's mathematics beliefs and teaching practice. *Journal for Research in Mathematics Education, 28(5), 550-576.*

Reys, R. E., Rybolt, J. F., Bestgen, B. J., & Wyatt, J. W. (1982). Processes used by good computational estimators. *Journal for Research in Mathematics Education, 183-201.*

Reys, B. J. (1985). Mental computation. *The Arithmetic Teacher, 32(6), 43–46.*

Sak, R., Şahin-Sak, İ. T., Öneren-Şendil, Ç., & Nas, E. (2021). Document analysis as a research method. *Kocaeli University Education Journal, 4(1), 227-250.*

Segovia, I. & Castro, E. (2009), Computational and measurement estimation; curriculum foundations and research carried out at the University of Granada. *Electronic Journal of Research in Educational Psyhology, 17(7), 499–536.*

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15(2), 4-14.*

Siegel, A. W., Goldsmith, L. T., & Madson, C. R. (1982). Skill in estimation problems of extent and numerosity. *Journal for Research in Mathematics Education, 13(3), 211 232*.

Siegler, R. S., & Booth, J. L. (2005). *Development of numerical estimation: A review*. In J. I. D. Campbell (Ed.), Handbook of mathematical cognition (pp. 197-212). New York: Psychology Press.

Segovia, I&Castro, E. (2009). Computational and measurement estimation: curriculum foundations and reseacrh carried out at the University of Granada, Mathematics didactics department. *Electronic Journal of Research in Educational Psychology, 17 (1), 499-536.*

Sowder, J. (1992). *Estimation and number sense*, In D, A, Grouws (Editör), Handbook of Research on Mathematics Teaching and Learning, New York: Macmillan.

Thompson, A. G. (1992). *Teachers' beliefs and conceptions: A synthesis of the research*. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 127-146). New York: Macmillan.

Trafton, P. (1986). Teaching computational estimation: Establishing an estimation mindset. In "estimation and Mental Computation"(H.L.Schoen and M. J. Zweng, eds.) pp.16 30. Nacional Council of Teachers Mathematics, Reston, Virginia.

Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. M. (2016). *Elementary and middle school mathematics.* London: Pearson Education UK.

Van de Walle J. A. (2004). *Elementary and middle school mathematics*. Teaching developmentally. Fifth edition. Boston: Allyn &Bacon.

Van de Walle, J. A., Karp, K. S., & Bay-Williams, J. W. (2019). *Teaching primary and secondary school mathematics with a developmental approach* (S. Durmuş, Trans.). Ankara: Nobel Publications.

Zübeyde, E. R. (2023). Examination of 7th Grade Students' Measurement Estimation Skills and Measurement Estimation Strategies. *Electronic Journal of Social Sciences, 22(87), 871-888.*

MATHEMATICS EDUCATION AND COOPERATIVE LEARNING

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Abstract

With the impact of the developed instructional programs, the collaborative learning and teaching approach, which enables individuals to actively participate in the learning process through constructivist understanding of learning environments, has gained importance (Driscoll, 2012; Özden, 2021; Taş and Akoğlu, 2020). The collaborative learning-teaching approach involves individuals taking responsibility both individually and as a group to achieve a common goal, developing the ability to establish positive connections, and engaging in learner-centered structured small group activities (Dirik, 2015). The purpose of this study is to review the existing literature on the collaborative learning approach in mathematics education. The literature review method was used in the study. It has been found that in an environment where collaborative learning is employed academically, students are more successful and the learned information is more permanently stored in memory (Shroyer, 1989). Additionally, it has been concluded that collaborative learning enhances students' self-efficacy and self-esteem (Senemoğlu, 2009) and reduces the tendency for students to exhibit unwanted behaviors (Ergün, 2023).

Keywords: Cooperative learning, Mathematics education, Mathematics

Introduction

The education-training process has qualitatively increased the process of structuring in the individual's mind with various methods and techniques, along with the constructivist approach, which is one of the contemporary approaches (Çetinkaya and Durmuş, 2021). With the influence of learning environments and teaching programs developed with this innovative approach, the collaborative learning and teaching approach, which allows the individual

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to actively participate in the learning process, has gained importance (Driscoll, 2012; Özden, 2021; Taş and Akoğlu, 2020).

This concept, called "Cooperative Learning" in English, has been translated into Turkish as cooperative learning (Açıkgöz, 1992). If we look at some definitions about cooperative learning; According to Gömleksiz (1993), cooperative learning; It is a learning approach in which students help each other on academic subjects by forming small heterogeneous groups in a classroom environment for a certain purpose, and in which there is specific evaluation and reward.

Cooperative learning-teaching approach is structured small group work that focuses on the learner and is based on certain principles, where individuals can work together to achieve the same goal, take responsibility individually and as a group, develop the ability to establish positive commitment, engage in group interaction (Dirik, 2015).

Cooperative learning is a learning approach in which students are put into small groups both in the classroom and in other environments, help each other learn about a subject for their common goals, increase their self-confidence, gain communication, thinking and problem-solving skills, and are actively involved in the learning and teaching process (Bayrakçeken, Doğan and Doymuş, 2015).

Cooperative learning can be defined as "the use of small groups for instructional purposes, enabling students to work together to maximize their own and other students' learning" (Holubec, Johnson & Johnson, 1993). In other words, everyone in the group is responsible for each other's learning and encourages each other to learn and use their abilities to the fullest (Açıkgöz, 1992).

Individuals who are active with the cooperative learning-teaching approach create their own ideas (Çetinkaya and Durmuş, 2021). At this stage, it develops individually and socially (Johnson and Johnson, 1999; Slavin, 1990).

Cooperative learning and teaching approach is an approach that enables groups to work effectively, allows students to acquire social skills such as leadership, decision-making, trust building, and conflict management, and provides a solution to the problem of gaining affective characteristics that have been neglected in education (Doymuş, Şimşek, & Şimşek, 2005; Johnson, Johnson and Holubec, 1991; Slavin, 1980).

Just because teachers bring students together in twos, threes or fours and do group work during lessons does not always mean that cooperative learning takes place (Ergün, 2023). In order for a team work to be a collaborative learning application, group members must have certain characteristics during the work (Ergün, 2023). Cooperative learning has basic features such as positive dependency, individual responsibility, creation of group spirit, the role of the teacher, use of social skills, face-to-face interaction and rewards (Johnson and Johnson, 1990; Johnson, Johnson and Holubec, 1993; Bayrakçeken et al., 2015, p. .3-5).

In the cooperative learning method, the teacher is no longer a constant transmitter of information as in teaching with the narrative method, but is a guide, supporter, guide and resource person for students to access information (Açıkgöz, 1992, 2007). In the cooperative learning method, the teacher regulates the relationships between groups and guides the interaction and cooperation within the group (Demirel, 2017); It encourages students, helps them learn, facilitates communication between students (Gillies, 2008), informs them about the points where the group gets stuck, and helps resolve conflicts that arise between students (Açıkgöz, 1992; Jolliffe, 2007). The teacher constantly circulates between the groups, watches the students, stimulates them by asking questions to stagnant groups, checks whether the students work in cooperation or not, and gives feedback to the students about their impressions (Açıkgöz, 1992; Jolliffe, 2007), provides feedback on the students' performance in the tasks they carry out and provides individual feedback to the students. praises their efforts (Gillies, 2008).

Group studies in cooperative learning and traditional cluster studies differ from each other (Ergün, 2023). Comparison of cooperative learning group work and traditional group work is given in Table 1 below (Nedeva et al., 2015).

Table 1. Comparison of Traditional Group Work and Cooperative Learning Group

Cooperative learning group	Traditional group work
Group members have a high level of positive dependence on each other.	Group members have a low level of dependence on each other.
Group members are responsible for both their own learning and the learning of other members of their group.	Group members are solely responsible for their own learning.
Emphasis is placed on team working skills.	Teamwork skills are not directly emphasized.
The group considers how they can improve the quality of their work and their efficiency in working together.	Traditional group work has no reflection on improving the quality of work done.
There is an emphasis on rewarding as a team.	Individual achievements are rewarded.

When Table 1 above is examined, it is thought that cooperative learning provides more meaningful learning than traditional learning.

When the cooperative learning method is examined, it is seen that there are many learning techniques that can be applied in classes related to this method (Ergün, 2023). While some of these techniques have well-defined and structured group tasks and rewards, in others, students are given more autonomy and less group reward is offered (Ergün, 2023). Some of these techniques can be listed as follows: Learning together, Academic Dissonance, Student Teams-Success Sections, Team-Game-Tournament, Team-Supported Individualization, Combined Collaborative Reading and Composition, Group Research, Cooperation-Collaboration, Discovery, Mutual Questioning, Combining, Combining. II, Let's Ask Together, Let's Learn Together (Açıkgöz, 2011; Owens, 2013; Senemoğlu, 2011).

Aim

The aim of the research is to examine articles and theses regarding the collaborative learning-teaching approach in mathematics education.

Method

In this research, the literature review method was used. Literature review is accepted as an effective research methodology in examining existing studies and synthesizing the results and findings in a systematic, transparent and reproducible way.

Data collection tool

In the study, the literature on collaborative learning in mathematics education was systematically scanned from YÖK TEZ and ULAKBİM databases. This process was carried out in accordance with the purpose of the research.

Analysis of Data

The collected data were examined using the document analysis method. Document analysis is a scientific research method that can be defined as the collection, review, query and analysis of various documents as the primary source of research data.

Results

When articles and theses are evaluated according to discipline fields, it is seen that the most studied discipline field is the "Mathematics" course (Çetinkaya and Durmuş, 2021). As it is known, mathematics course; It requires a series of skills such as explanation, organization, pattern search, comparison, classification, application, inference, modeling, abstraction, persuasion, generalization, analysis and synthesis (Boz, 2018; Kutluk, 2011; Olkun and Toluk, 2012; Yaman). and Umay, 2013). Considering that the mathematics course requires multi-stage processes and has a challenging learning process (Konukoğlu, 2019; Mumcu, 2018), researchers may have designed their research with a cooperative learning-teaching approach as a way to overcome these difficulties and achieve permanent learning (Çetinkaya and Durmuş, 2021). However, the cooperative learning-teaching approach is an approach that aims to achieve learning at the highest level (Yılmaz, 2007) and appeals to different learning styles and different discipline areas (İleri, Selvi and Köse, 2020; Johnson, Johnson and Smith, 2014; Kardaş and Cemal, 2015; Oktan and Budak, 2021; Önder and Sılay, 2015). From this perspective, it is a learning-teaching approach that should be used in different courses (Çetinkaya and Durmuş, 2021).

When articles and theses designed with a cooperative learning-teaching approach are examined; It has been determined that it was mostly designed with the "Jigsaw Technique" (Çetinkaya and Durmuş, 2021). Due to the way it is applied, the Jigsaw technique creates a rich portfolio with the principles of forming heterogeneous teams, giving students the opportunity to specialize on a subject, each group member being responsible for learning the subject they are experts in, and returning to their own teams and teaching the subject they have learned to others (Kocabaş, 2016). It can be considered as the reason (Çetinkaya and Durmuş, 2021).

When the articles and theses examined in the research are examined in depth; It has been revealed as a common emphasis that courses designed with a cooperative learning-teaching approach positively contribute to basic competencies and skills such as academic success, motivation, attitude and self-efficacy on learners (Çetinkaya and Durmuş, 2021). Studies on the effect of cooperative learning-teaching approach on affective skills also support this situation (Genç and Şahin, 2015; Öztürk and Kalyoncu, 2018; Tuğral and Güvenç, 2016; Yıldız, Ağgül, Çalıkler and Şimşek, 2021).

Shroyer (1989) stated that students are more successful academically in an environment where lessons are taught through cooperative learning, the information learned is retained in memory for a longer period of time, and students show more cognitive development. Since the student is responsible for his or her own learning in cooperative learning, the tendency to exhibit undesirable behavior decreases by concentrating more actively on the lesson (Ergün, 2023).

Senemoğlu (2009) stated that cooperative learning improves students' feelings of self-efficacy and self-esteem, teaches students to be tolerant and respectful of others' ideas, and provides the individual with the ability to empathize.

Suggestions

It has been concluded that intensive experimental studies have been carried out with the cooperative learning-teaching approach. However, it appears that longitudinal studies designed with a cooperative learning-teaching approach are limited in the literature. It may be recommended to conduct studies to reveal the long-term effects of the cooperative learning-teaching approach on areas such as learning and social skill development.

Researchers may be advised to conduct compilation studies over a wider range of years, by scanning different databases and including foreign sources.

References

Açıkgöz, K. Ü. (1992). *Cooperative learning: Theory research practice*. Malatya: Uğurel Printing House

Açıkgöz, K. Ü. (2007). *Effective learning and teaching*. (7th Edition). Izmir: Biliş Publishing

Açıkgöz, K. Ü. (2011). *Active learning*. (12th Edition). İzmir: Biliş Publishing.

Bayrakçeken, S., Doymuş, K. & Doğan, A. (2015). *Cooperative learning model and its application*. (2nd Edition), Ankara: Pegem Akademi Publishing.

Çetinkaya, S. and Durmuş, T. (2021). A compilation study on cooperative learning-teaching approach. *Western Anatolian Journal of Educational Sciences, 12(2).*

Demirel, Ö. (2017). *Program development in education from theory to practice*. (25th Edition). Ankara: Pegem Akademi Publishing.

Dirik, M.Z. (2015). *Teaching principles and methods*. Pegem Academy.

Doymuş, K., Şimşek, Ü. and Şimşek, U. (2005). Review on collaborative learning method: i. collaborative learning method and studies related to the method. *Erzincan University Faculty of Education Journal, 7(1).*

Driscoll, M. P. (2012). *Teaching processes and learning psychology*. Anı Publishing.

Ergün, M. 2023. *The effects of cooperative learning techniques on success and learning retention in decimal notation in fifth grade mathematics course*. Unpublished master's thesis, Çukurova University Social Sciences Institute, Adana.

Youth. M. and Şahin, F. (2015). The effect of cooperative learning on achievement and attitude. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education, 9(1).*

Gillies, R. M. (2008). *Teachers' and students' verbal behaviors during cooperative learning*. R. M. Gillies, A. Ashman & J. Terwel (Eds.), In the teacher's role in implementing cooperative learning in the classroom, (p. 238-257). New York: Springer.

Gömleksiz, M. (1993). *The effect of cooperative learning method and traditional method on democratic attitudes and achievement*. Unpublished doctoral thesis. Çukurova University, Adana, Türkiye.

Holubec, E. J., Johnson, D. W., & Johnson, R. T. (1993). *The new circles of learning: Cooperation in the classroom and school.* Interaction Book: Edina, MN.

İleri, Y. E., Selvi, M. and Köse, M. (2020). The effect of cooperative learning approach on academic achievement in science education: a meta-analysis study. *Ihlara Journal of Educational Research, 5(1).*

Johnson, D.W. & Johnson, R. T. (1990). *Cooperative Learning and Achievement. S. Sharan(Ed.), Cooperative Learning* (sf.23-38). New York: Praeger.

Johnson, D. W., Johnson, R. T. ve Holubec, E. J. (1991). *Cooperation in the classroom. Interaction Book Company.*

Johnson, D. W., Johnson, R., & Holubec, E. (1993). *Circles of learning* (4th ed.). Edina, MN: Interaction Book Company.

Johnson D. W. ve Johnson R. T. (1999). *Making cooperative learning work. Theory into Practice*, 38(2).

Johnson, D. W., Johnson, R. T. ve Smith, K. A. (2014). *Cooperative learning: Improving university instruction by basing practice on validated theory.* Journal on Excellence in University Teaching, 25(4).

Jolliffe, W. (2007). *Cooperative learning in the classroom: Putting it into practise*. (1st Edition). London: Paul Chapman Publishing.

Kardaş, M. and Cemal, S. (2015). The relationship between cooperative learning techniques and student opinions regarding success, attitudes and practices in teaching Turkish. *Mustafa Kemal University Social Sciences Institute Journal, 12(30).*

Konukoğlu, L., Ağaç G. and Özmantar, M. F. (2019). Examination of Republican period primary school mathematics curriculum from the perspective of mathematical literacy. *Western Anatolian Journal of Educational Sciences, 10(2).*

Kutluk, B. (2011). *Examining primary school mathematics teachers' knowledge of student difficulties regarding the concept of pattern*. [Unpublished PhD Thesis, Dokuz Eylül University+. National Dissertation Center.

Kocabaş, A. (2016). *Cooperative learning handbook*. Pegem Academy.

Mumcu, H. Y. (2018). Examining mathematical association skill in theoretical dimension: example of the concept of derivative. *Turkish Journal of Computer and Mathematics Education, 9(2).*

Nedeva, V., Shivacheva, G., Zheleva, H., & Atanasova, V. (2015). Improving cooperative learning activities by new Moodle features, *Journal of the Faculty of Technics and Technologie, 3 (3).*

Olkun, S. and Toluk Uçar, Z. (2012). *Activity-based mathematics teaching in elementary education* (5th ed.). Egitim Kitap Publishing.

Owens, J. E. (2013). *Cooperative learning in secondary mathematics: research and theory*. In J. E. Pederson & A. D. Digby (Eds.), In secondary schools and cooperative learning: Theories, models and strategies, (p. 153-183). New York: Routledge

Önder, F. and Sılay, İ. (2015). The effect of cooperative learning method on the success of students with different learning styles in physics course. *Kastamonu Education Journal, 23(2).*

Özden, Y. (20121*). Learning-teaching*. Pegem Academy.

Öztürk, G. and Kalyoncu, N. (2018). The effect of the cooperative learning method used in musical hearing education on student anxiety and success. *Journal of Measurement and Evaluation in Education and Psychology, 9(4).*

Senemoğlu, N. (2009). *Development, learning and teaching from theory to practice*. (14th Edition), Ankara: Pegem Publishing.

Senemoğlu, N. (2011). *Developmental learning and teaching from theory to practice*. (20th Edition). Ankara: Pegem Akademi Publishing.

Slavin, R. E. (1980). Cooperative learning. *Review of Educational Research, 50(2).*

Slavin, R. E. (1990). Research on cooperative learning: Consensus and controversy. *Educational Leadership, 47(4).*

Shroyer, G. (1989). *Learning Outcomes from Cooperative Learning Teaching*. Distributed to Participants of the BBSCS Middle School Project Fieldtest, Workshop. Colorado Springs: CO: BSCS.

Taş, G. and Akoğlu, K. (2020). The effect of cooperative learning approach in teaching social studies: a meta-synthesis study. *Turkish Journal of Educational Sciences, 18(2).*

Tuğral, Z. and Güvenç, H. (2016). Effects of Cooperative Learning on High School Students' Mathematics Self-Efficacy Perceptions, Achievement and Active Participation. *Ahi Evran University Kırşehir Faculty of Education Journal, 17(2).*

Yaman, H. and Umay, A. (2013). Primary school students' perception of mathematical patterns according to their presentation styles. *Hacettepe University Faculty of Education Journal, 28(28-1).*

Yıldız, E., Ağgül, Ö., Çalıklık, Ş. and Şimşek, Ü. (2021). The effects of educational games and cooperative learning on 6th grade students' academic achievement, social skills and learning motivation. *Anemon Muş Alparslan University Journal of Social Sciences, 8(6).*

Yilmaz, M. (2007). Cooperative learning in visual arts education. *Kastamonu Education Journal, 15(2).*

USE OF WEB TOOLS IN MATHEMATICS EDUCATION

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Abstract

This study was conducted to examine and interpret the features of web tools used in mathematics education, their areas of use in mathematics education, and which web tools can be used more functionally. In this study, existing articles and theses in Dergipark, Google Scholar, and National Thesis Center were examined, and the data were analyzed by content analysis using case study, one of the qualitative research methods. The features of web 1.0, web 2.0 and web 3.0 tools included in the study are explained separately, and information and suggestions are given about which web tool is used in mathematics education, how it is used and which one is more functional and accessible. As a result, it shows the necessity of integrating into mathematics education with the correct use of web tools that contribute to the constructivist mathematics education used today, keep the student active, come to the fore in gaining mathematical skills and make learning permanent.

Key Words: Technology, web 1.0, web 2.0, web 3.0, mathematics education.

Introduction

There are many developing areas today, but the most important of these areas is the developments in the technological field. Developments in the technological field need to be used in daily life, business life and education (Aydoğdu, and Tutak, 2017). Since education is an important building block of society that sheds light on the future, the use of technology in education is an essential need compared to other fields. There are many ways to combine education with technology; web tools, online training systems, educational software programs, etc. There are many alternatives.

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Educational software programs are computer software used for teaching or self-learning purposes. Educational software types; tutorial programs, exercise-application software, educational games, web-based learning, open-ended learning environments, hypermedia, tests and simulations (URL-1).

Web Based Mathematics "WTM" is where education is carried out independently of time and place; It can be defined as an education model in which the computer is used for research and communication purposes, as a teaching and presentation tool (Özüsağlam, 2007). Web 1.0 tools are the first version of the technology (until the 1990s), providing access to information, but it is a technological tool that has a one-way transfer, contains only text, and does not interact with the user. Web 2.0 tools (emerged in 2004) are a more recent version that include forums, blogs, comments, and social networks and allow information sharing; Social networks, collaboration and sharing opportunities, and distance education provide the opportunity for person-to-person connection (Yılmaz, 2022). Web 3.0 technology (developed in 2010) is advanced enough to provide a reliable and data-oriented user interface based on advanced software programs such as artificial intelligence, and blockchains, metadata and semantic web are software available through Web 3.0 (URL-2). Web 4.0 (activated in 2016) is the most current version of the web, a technology that moves away from physical disks and is based entirely on virtual networks. This technology can detect problems and produce solutions, especially with coded artificial intelligence (URL-3).

The fact that web tools, especially web 2.0 and web 3.0 tools, can create education-ready content in an interactive manner, taking into account the needs and wishes of the user, reveals that these tools are good alternatives that can be used in education. By adapting these alternatives to the field of mathematics, it can be thought that both technologies can be very useful.

Aim

The purpose of this study is to make determinations about which of the features available in web tools would be more useful for today's mathematics education or which feature available in the web tool would be more beneficial for the field of mathematics.

Method

In this research, the features and usage of web 1.0, web 2.0 and web 3.0 tools are presented on the basis of mathematics education. Literature review was used as the method in this research.

Data Collection Tools and Analysis

In the study, literature on mathematics education was collected from YÖK TEZ and ULAKBİM databases with a systematic scanning method.

This process was carried out carefully in accordance with the purpose of the research. The collected data were examined using the content analysis method.

Results

In this section, the features of web tools and how they are used in mathematics education are explained.

Web 1.0

The Web 1.0 era appears static and one-way. In other words, it can mostly be described as a read-only web. The main purpose of websites was to publish information and create an online presence so that it could be accessed by anyone at any time (Hörküç, 2023).

Because Web 1.0 tools have a one-way communication network and at the same time position the student passively, it has become a type of web whose frequency of use decreases as technology development in mathematics education increases. Although Web 1.0 tools are used in mathematics education based on lectures and only play a role in conveying the subject, they are not compatible with the constructivist education approach used today. Web 1.0 tools are web tools used mostly in traditional mathematics education. In the traditional approach to mathematics education, the most preferred web 1.0 tools are Okulistik, Morpa Campus, various educational sites, videos, digital images/photos, etc. There have been tools such as (Uğuz, 2022).

Web 2.0

Web 2.0; It has become a world where internet content created by people with the logic of web 1.0 can be changed by the visitors of the page, and control has passed into human hands (Gökçearslan, 2011). The term Web 2.0 was first defined by O'Reilly at the "Media Live International" brainstorming conference in 2004. According to this; It has been expressed as the second wave, which is based on collaboration with different web activities such as wikis, blogs, forums, tagging, and search engine optimization based on user communities and allows the dissemination of information among users (Hörküç, 2023).

Web 2.0 technologies are tools that allow individuals to create content on the web and collaborate by eliminating geographical and temporal differences (Arabacı, 2021). Web 2.0 tools are frequently used web tools in mathematics education because they provide interactive education and keep the student actively engaged. Web 2.0 tools are also an up-to-date web version that supports teaching, has a two-way communication network that allows the student to create content, and has advanced social features. These tools enable the creation of interactive and engaging activities, foster a collaborative learning environment, and enhance students' understanding of mathematical concepts. Additionally, the implementation of intelligent algorithms in web applications has aided learning processes by allowing personalized and adaptive mathematics exercises for students (Miguel, 2017). With WEB 2.0 tools, lessons become fun and enjoyable, increase memorability, and develop a positive attitude towards the course (Dursun and Tertemiz, 2021).

Web 2.0 applications used in education, 3D tools, survey, animation, avalar, barcode, physical education, e-book, drawing and photography, diary keeping, story, cartoon making, coding, logo making, mathematics, online exam, game, virtual reality. It can be grouped as virtual wall and board, certificate, classroom management, slide and presentation, team building, calendar, flipped classroom, distance education, video conference, web page, foreign language tools and other tools (Akbaba and Ertaş Kılıç, 2022).

In addition, the use of Web 2.0 tools such as smart boards, Moodle, Kahoot Edmodo, Edpuzzle, Wordwall, Geogebra has been found to be effective in assimilating information, applying experiences and improving intellectual development in mathematics education (Rana, 2019).

Web 3.0

The Web 3.0 era is also called the "semantic web". This model is called the semantic web by envisaging that the contents in the web infrastructure, where the content is created entirely by humans and these contents are read or used by humans, are readable and understandable by computers (Hörküç, 2023). Thanks to RDF and OWL languages and similar technologies developed with the Web 3.0 era, the information obtained from web pages and the contents of users were "interpreted" by machines and a new web environment was created. Accordingly, it is aimed to customize and optimize online search according to the users' history, interests and wishes by making arrangements for how the content will be searched and displayed by users (Ersöz, 2020).

Web 3.0 is used in mathematics education to improve collaborative learning and problem-solving skills (Morocho and Lara, 2022). Web 3.0 tools keep the student active and support individual education according to the student's wishes and mathematics learning characteristics. It can be used at various educational levels as interactive platforms help teach mathematics effectively. Additionally, web-based virtual laboratories are designed to support students in problem solving and program writing, especially during the pandemic when online learning is common (Harris,2022). In addition, games and web portals can be developed for students in primary, secondary and high schools, as they can make abstract concepts in mathematics education, such as teaching fractions and ratio-proportion concepts, concrete (Elvira, 2019). These tools not only facilitate understanding of mathematical concepts but also improve motivation, search proficiency, and programming skills among students.

Results

With the widespread use of information communication technology tools and access to the internet, individuals' daily life routines have shifted from traditional environments to digital platforms (Bircan and Akman, 2022). Due to these technological shifts in education, the need to use web tools has emerged (Tutak, et al. 2018). The main reasons why web 1.0 tools do not appeal to today's mathematics education compared to web 2.0 and web 3.0 tools are that they have a fixed interface and one-way communication. That's why it is a rarely used web type. Web 2.0 tools come to the fore in terms of providing two-way interaction, providing an environment where users can produce content, allowing students to repeat as much as they want, learning the subject and practicing. Although web 3.0 tools offer an up-to-date, more realistic and concrete mathematics education compared to web 2.0, the ease of access, multitude of applications and the high rate of smart board usage show that the web 2.0 version is more usable and supports mathematics teaching more functionally. The technology cost required to use Web 2.0 tools is also more accessible than Web 3.0. In mathematics education, concretizing the subject, supporting reasoning, developing processing ability, etc. Web 2.0 tools have been found to be more suitable in terms of accessibility, usage and diversity of available tools that support important skills such as.

Suggestions

Considering the results of the literature review on the use of web tools in mathematics education, suggestions are given below.

- In order to learn mathematics in a more concrete and permanent way, the use of technology should be increased according to the student's interests, needs and wishes.
- In order to use web tools correctly, teachers and students must have the necessary knowledge level.
- As the versions of web tools change, the areas in which they are functional change, so the appropriate web tool should be used wherever necessary.
- The use of web tools should be based on the constructivist approach in mathematics education.
- The use of web tools should be included significantly in order for the student to develop a positive attitude towards the mathematics course.

References

Akbaba, K., & Ertaş Kılıç, H. (2022). The Effect of Web 2.0 Applications on Students' Attitudes Towards Science and Technology Use. *Erzincan University Faculty of Education Journal, 24(1), 130-139.*

Arabacı, A. (2021). *The effect of activities organized with Web 2.0 tools on some field competencies of mathematics teacher candidates* (Unpublished Master's thesis, Amasya University).

Aydoğdu, M. and Tutak, T. (2017). Developing Mathematical Modeling Activities for Secondary School 8th Graders. *The Journal of Academic Social Science (54), 155-166.*

Bircan, M. A. and Akman, E. (2022). *Teaching with Educational Digital Games in Primary School*, Ankara: Vizetek Publishing,

Daniel, Morocho-Lara., Patricio, Miranda-Ramos., Héctor, Neto-Chusín., Sarah, Iza-Pazmiño. (2022). Collaborative tools web 3.0 in the teaching of mathematics in times of Covid 19 pandemic. 775-779. doi: 10.1109/educon52537.2022.9766786

Denny, Haris., Edy, Rahman, Syahputra., Chairunnisah. (2022). The development of web-based virtual laboratory for programming language in mathematics education. Nucleation and Atmospheric Aerosols, doi: 10.1063/5.0113716

Dursun, H., & Tertemiz, N. I. (2021). Examining the Reflection of Online Web 2.0 Tools Teaching in the Mathematics Lesson Plans of Classroom Teacher Candidates. *Turkish Studies-Educational Sciences, 16(1).*

Elvira, G., Sabirova., Tatyana, Viktorovna, Fedorova., Natalya, N., Sandalova. (2019). Features and Advantages of Using Websites in Teaching Mathematics (Interactive Educational Platform UCHI.ru). *Eurasia journal of mathematics, science and technology education, 15(5) doi: 10.29333/EJMSTE/108367*

Ersöz, B. (2020). New generation web paradigm - web 4.0. *Journal of Computer Science and Technologies, 1(2), 58-65.*

Gökçearslan, Ş. (2011). Semantic web (Web 3.0) and its use for educational purposes. *Journal of Educational Technology Research, 2(4), 1-15.*

Hörküç, İ. (2023). Using Web 3.0 in Education: Potential and Challenges. *International Journal of Social Sciences, 7(30), 326-335.*

Miguel, Hernan, Gonzalez. (2017). Aplicación web para la enseñanza y aprendizaje de matemáticas.

Özüsağlam, E. (2007). Web Based Mathematics Teaching and Lesson Presentation Example. *Pamukkale University Faculty of Education Journal, 21(21), 33-43.*

Rana, Zein. (2019). Exploring the uses of blogs and wikis as teaching and learning tools in mathematics: findings and implications. 10356-10363. doi: 10.21125/EDULEARN.2019.2601

Tutak, T., İlhan, A., İç, Ü. and Kılıçarslan, S. (2018). The Effects of Computer Aided Mathematics Teaching on Pre-service Mathematics Teachers' Views on Learning Processes. *Journal of Turkish Studies, 13(27), 1509-1524., Doi: 10.7827/TurkishStudies.14341*

Uğuz, U. (2022). *Classroom teachers' mathematics teaching self-efficacy beliefs and their views on distance education mathematics teaching during the covid-19 pandemic period (Afyonkarahisar sample)* (Unpublished Master's thesis, Afyon Kocatepe University Social Sciences Institute).

History of WEB 1.0, 2.0, 3.0 and 4.0 (Ö. Yılmaz, trans.). (2022). *Maltepe University Faculty of Communication Journal, 8(2), 351-359.*

URL-1: Basic Features of Educational Software https://egitselyaziliminsosyalozelliği.wordpress.com/egitsel-yazilimlarin-bolumleri/#:~:text=%C3%96%C4%9Fretim%20veya%20kendi%20kendine%20%C3%B6 %C4%9Braking%20purpose%C4%B1yla%20use%C4%B1lan%20computer%20write%C4%B1l%C4%B1ms%C4%B1d%C4%B1r (E. T. =9.05.2024)

URL-2: Web 2 etc. Web 3: What's the Difference and Why It Matters https://www.spiceworks.com/tech/tech-general/articles/web-2-vs-web-3/ (E. T. =9.05.2024)

URL-3: WEB 1.0-WEB 2.0-WEB 3.0-WEB 4.0 "WHAT IS THIS WEB?" https://esmacalisir.com/2018/01/09/web-1-0-web-2-0-web-3-0-web-4-0-nedir-bu-web/ (E.T. =9.05.2024)

SOLVING GEOMETRY PROBLEMS: A STUDY ON SECONDARY SCHOOL STUDENTS' PROBLEM SOLVING STRATEGIES

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Abstract

This research; It examines the problem-solving strategies that secondary school students use most when solving geometry problems and the effects of these strategies on student success. The study population of the research consists of articles, theses, books and various databases written on this subject. Document analysis method, which is one of the qualitative research methods, was used as the research method and data analysis method. As a result of the research; It has been noticed that the problem-solving strategies most used by students when solving geometry problems are as follows; prediction and control, making systematic lists, drawing figures, simplifying the problem, working backwards and finding relationships and patterns. However, it is seen that problem-solving strategies positively affect student success and contribute to the development of mathematical literacy.

Key Words: Secondary school, geometry, problem solving strategy, mathematics achievement

Introduction

To learn what geometry is, we first need to look at the origin of this word. The word geometry is a name formed by combining the Greek words "Geo" (ground) and "metro" (measurement) and means "measurement of land". According to Herodotus (450 BC), Geometry first appeared in Ancient Egypt and was used to produce solutions to people's daily problems, such as reconstructing farmers' lost land boundaries due to the overflow of the Nile River every year and making agricultural calculations as well as predicting astronomical events. . In addition to being one of the most important areas of mathematics, geometry is also one of the first sources of mathematics,

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along with arithmetic. According to Chaudhary (2019) as quoted by Kelly and Ladd (1986), geometry is one of the most useful and important branches of mathematics and, in addition to containing a tremendous range of ideas, it can be examined in many different ways, and is also intertwined with other subjects and different views on human activities. The basic ideas of a mathematical system originated in geometry about twenty-two or twenty-three hundred years ago. When looking at the origins and history of geometry, it becomes clear that this discipline has played an important role in human history. Although its origins date back to ancient Egypt, geometry's importance in today's mathematical thinking and problem-solving processes still continues. As stated by Kelly and Ladd (1986), seeing the fundamental position of geometry in mathematics and its connection with different fields is important to increase interest in this discipline and develop mathematical thinking skills. Geometry should be viewed as a critical tool not only for surveying land and predicting astronomical events, but also for providing solutions to problems people face in their daily lives. Therefore, increasing interest and understanding of geometry can contribute to the development of mathematical discoveries and problem-solving skills. Before focusing on what problem solving is in geometry, it would be useful to look at what "problems and problem solving" are. For example, as quoted by Gelbal (1991) from Baykul and Aşkar (1987), John Dewey, the founder of the problem-based learning approach, defined the problem as anything that confuses the human mind, challenges it and obscures belief. As can be understood from here, the problem can be seen as obstacles that we may encounter in every field in our daily lives that challenge us, that we must overcome, or encouraging factors that enable us to think. Problem solving, when faced with a problem, is to analyze the current situation, try to understand the root of the problem, and then take steps to solve the problem by developing appropriate strategies (Özsoy, 2005). Thus, we can summarize the relationship between problems and problem solving as follows: All the obstacles and difficulties we encounter throughout our lives are problems, and finding a way to understand the difficulties and overcome them and move on that path is to solve this problem (Tutak, et al., 2018). The importance of geometry in the history of mathematics is closely related to problem solving. However, this feature of geometry is not limited only to the history of mathematics; Today, it plays a critical role in developing students' problem-solving abilities. Geometry is an important tool for solving problems we frequently encounter in daily life. Creating solutions by thinking about issues such as the functionality and ergonomics of shapes reveals the problem-solving aspect of geometry. This sub-branch of mathematics encourages people to find more effective solutions to problems by improving their critical thinking skills. (Yaprak,2019). Especially at the secondary school level, teaching geometry offers students the opportunity to put their mathematical thinking skills into practice and strengthens their relationship with mathematics. However, there are difficulties encountered by secondary school students when solving geometry problems, and there are often deficiencies in students' understanding and solving of geometry problems. The branch of mathematics in which students in our country experience the most difficulties and have difficulty in achieving success seems to be geometry (Yıldırım, 2015). These difficulties experienced by students in solving mathematical problems and problems related to geometry, which is a sub-branch of mathematics, can be resolved by using problem-solving strategies. In other words, it is necessary to determine your own path or try to solve the problem by following a path that has been tried before. As it is known, in mathematics and geometry, there is never a single solution to a problem. Some problems can be solved immediately and there may be no need to try different methods. However, sometimes we may encounter problems that are difficult to solve. In this case, it is essential to develop a strategy to solve the problem, as known ways may be incomplete. As Çınar (2013) stated, "Since complex problems are difficult as a whole, we develop specific strategies for solution. ''It is seen that problem solving strategies are important when solving geometry problems, and students can use these strategies to cope with problems and solve geometry problems more effectively.

Purpose of the Research

The purpose of this research is to try to understand the importance of problem-solving strategies in destiny while solving geometry problems, to examine what the most accepted strategies are and the effects of these strategies on mathematics achievement and to make suggestions on the subject. For this purpose, answers were sought to the following sub-problems.

1. What are the strategies used by 5th, 6th, 7th and 8th grade students while solving geometry problems?

2. What are the effects of these strategies used on students' success?

Method

This research aims to understand the strategies that students adopt while solving geometry problems and to examine the effect of these strategies on students' mathematics achievement. Qualitative research method was used in this study.

Model of the Research

The design of this research was carried out using the document analysis method, which is a qualitative research design. Document analysis is a research method that provides in-depth understanding by systematically examining written materials and aims to compile, synthesize and analyze existing information. In other words, document analysis is a series of processes that occur during the examination and evaluation of printed and electronic (computer-based and internet-accessible) materials (Bowen, 2009). This method provides a comprehensive assessment of existing knowledge by scanning the literature on geometry teaching and problem-solving strategies.

Data Source

The sources that constitute the sample of the research consist of academic sources focusing on geometry teaching and problem-solving strategies. These resources are available in various databases such as Higher Education Council Thesis Center (YÖK THESIS), Google Scholar, University Journals, Books and National Academic Network and Information Center (ULAKBİLİM). Articles and theses have been carefully selected based on criteria determined in accordance with the scope of the subject. These criteria include factors such as suitability for the purposes of the study, methodological accuracy, timeliness and effectiveness. This selection process was conducted carefully to ensure the accuracy and reliability of the study.

Data Collection Tool and Process

The data collection process was carried out by reviewing academic resources focusing on geometry teaching and problem-solving strategies. This process enabled the compilation of the information necessary to achieve the purpose of the research. The data sources mentioned above were used as data collection tools. The articles and theses in these databases were selected in accordance with the subject focusing on geometry teaching and problem-solving strategies and the above-mentioned criteria (suitability for the purposes of the study, methodological accuracy, currency and effectiveness). Data obtained from each source was meticulously examined and sorted to provide important information regarding the focus of the study. However, the data collection process has been carefully conducted to ensure the accuracy and reliability of the research, and all articles and theses contain important findings on the topics examined and provide the necessary data to achieve the aims of the research.

Analysis of Data

In the data analysis phase of this study, the data collected by the document analysis method was first examined using the document analysis method in line with the questions to which the research sought answers. This process aimed to evaluate the strategies used by students while solving geometry problems and the effects of these strategies on their success. According to Özkan (2019) from O'leary (2004), document review refers to both a data collection method and a form of analysis. In line with the purpose of this research, this method was chosen because it is expected to find answers to the problems stated in the purpose of the research by examining the documents related to the subject in the literature. Thanks to this method, the data was systematically examined and important steps were taken to achieve the aims of the research.

Findings

Before focusing on the questions that the research seeks to answer, it is necessary to look at the generally accepted problem solving stages in problem solving. Because when we look at the literature on problem solving strategies, it is seen that there is a lot of emphasis on problem solving stages. The most accepted method for problem solving stages and used in academic studies is the method of Mathematician Polya (1957). According to him, the problem solving process takes place in four stages:

1. Understanding: The first step is to understand the problem. By reading the problem, we try to understand the information given and what is asked. It is difficult to produce a correct solution without understanding what the problem asks.

2. Planning: It is necessary to make a plan to solve the problem. Various strategies can be used in this step, such as breaking the problem into parts, applying similar strategies to similar previous problems, or creating a model.

3. Execution: This is the phase of implementing the determined plan. Using the selected strategy, we solve the problem step by step.

4. Control (Review): After solving the problem, it is necessary to check the result. If the result is not expected, we try to find out where the mistake was made by going over the steps again.

Polya (1957)'s problem solving approach based on these stages is used as a very effective tool in solving mathematical problems and developing general problem solving skills. When students use strategies to solve problems, they must complete these stages completely. As a result of a missing or incorrect step, the problem solution does not reach its conclusion and remains incomplete.

Problem Solving Strategies

Now, at this stage of the study, it will focus on the first question of the research, "What are the strategies used by 5th, 6th, 7th and 8th grade students while solving geometry problems?" Looking at the research, there are many different strategies used in the literature when solving geometry questions. For example, when we look at the studies conducted in this field, the strategies used by students when solving geometry problems go beyond the generally accepted strategies. When looking at the study conducted by Yıldırım (2015), it is noticed that special problem solving strategies such as numerical approach, numerical and geometric approach, focusing on side lengths, finding the Pythagorean relation, determining possible triangles, taking symmetry, and iterative and functional strategies are used. These strategies may be appropriate for students to use when solving geometry questions, if the geometry problem is given only as a shape and if the students' prior knowledge is evoked and the solution depends on the use of this information. However, mathematics and geometry questions are skill-based questions called new generation questions. New generation questions are questions that measure abilities specific to certain fields in the education curriculum and test students' skills in understanding, interpreting, reasoning and analyzing what they read (Karakeçe, 2021). To solve these questions, strategies that develop and guide the student's problem-solving skills should be used. For this purpose, when we look at the most frequently used problem solving strategies in geometry, prediction and control, making a systematic list, drawing shapes, simplifying the problem, working backwards, and finding relationships and patterns come to the fore (Temel, 2018). Now, let's discuss what these problem-solving strategies are under subheadings.

The prediction and verification strategy is used in problems with little data or too many unknowns. This strategy guesses the answer to the question and checks the accuracy of this guess. If true, the problem is solved; However, if it is wrong, new guesses are made and this process continues until the correct answer is reached. This method is also known as the trial-and-error method.

The systematic list-making strategy is an approach used to solve complex problems. This strategy is effective in situations that require identifying all possible situations related to the problem. Creating a systematic list by proceeding from beginning to end or from end to end makes the solution process easier.

The shape drawing strategy is a method used to solve complex situations. We concretize problems by representing them with geometric or non-geometric shapes, points or tables. In this way, we can provide the solution to the problem more easily by representing the questions visually and transforming them into a mathematical solution step by step.

The strategy of problem simplification is that when some problems involve complex structures or large numbers, solutions can be quite difficult to find. In this case, a simplification strategy can be used to make the problem more understandable. This strategy can facilitate the solution process by creating a version of the problem similar to the original but on a smaller scale. For example, in mathematics problems, it may become easier to find the solution to the problem by starting with a smaller equation instead of a complex equation (Temel, 2018).

The backward working strategy is an approach that starts from the result, goes back step by step, destroys the data and aims to reach the first data. In this method, the sought value must be reached when the beginning is reached.

Correlation is defined as the pattern finding strategy, the perception of order and the placement, copying or extension of this order among objects. This strategy involves exploring the trajectory of variables; For example, finding out how numbers progress, according to which rule they are formulated, and predicting the next number (Çınar, 2013).

The Effect of Problem Solving Strategies on Student Achievement

At this stage, the second question of the research, "What are the effects of these strategies on student success?", was focused on and previous studies were examined and it was examined whether the effect of problem-solving strategies on student success was positive, neutral or negative. Most studies indicate that problem-solving strategies have a positive impact on students' problem-solving process and enable the student to understand the problem, develop a solution accordingly and reach a conclusion. For example, according to the study conducted by Temel (2018), a strong relationship was found between problem-solving strategies and mathematical literacy, and therefore, in order to improve mathematical literacy, the use of problem-solving strategies should be encouraged in educational environments, and problems focusing on these strategies should be included in textbooks. Considering the study conducted by Altun and Arslan (2006), it can be said that the training focused on problem-solving strategies positively affects the problem-solving attitude. Additionally, in the study conducted by Altun et al. (2007), it was found that problem-solving strategies such as simplifying the problem, making a systematic list, and drawing figures were effective in increasing problem-solving success. Looking at these studies, it can be said that problem-solving strategies have a positive effect on student success. However, when Arsal (2016)'s study was examined, it was emphasized that the strategies required to solve a problem are important, but the priority criterion is understanding the problem, and he said that what is required for students' success in mathematics is not knowing the problem-solving strategies but understanding the problem. However, looking at the results of the research conducted by Altun (1995), it appears that strategies for understanding the problem play a critical role in solving the problem. In other words, Altun (1995) and Arsal (2016) emphasize that most problem-solving strategies do not play a very important role in solving the problem, but only have an effect as long as they help understanding the problem, which is the first of Polya's (1957) problem-solving stages.

Discussion

The aim of the research was to determine which problem-solving strategies secondary school students use most when solving geometry problems and to examine the effect of these strategies on students' mathematics achievement. For this purpose, answers to the relevant questions were sought by using articles, theses and books in the literature. The findings revealed that students used different strategies when solving geometry problems. Looking at the studies of Yıldırım (2015) and Temel (2018), it can be seen that there are almost 40 problem solving strategies. When looking at the context of use of many of these strategies, it was noticed that they were not aimed at solving the new generation questions in the curriculum. Additionally, since it is both difficult and unnecessary for students to know all of these problem-solving strategies, it is more important for them to focus on the ones that work best. When the findings are examined at this point, the basic approaches observed regarding the strategies that students most frequently use when solving geometry problems are as follows: prediction and control, making a systematic list, drawing shapes, simplifying the problem, working backwards and finding relationships and patterns. These strategies appear to help students understand the problem and guide the solution process. However, in order for problem-solving strategies to be used effectively, students must be guided appropriately and encouraged to apply these strategies. For example, Arsal (2016) says that teachers should exemplify problem-solving strategies in mathematics lessons with their own practices and encourage their students to use these strategies. The results of studies on the effect of the strategies students use while solving geometry problems on student success vary, and in general, it is seen that problem-solving strategies positively affect student success and contribute to the development of mathematical literacy (Aydoğdu et al. 2014). When the studies of Altun et al. (2007), Yıldırım (2015), Temel (2018), Çınar (2013) are examined, a significant direct proportion can be seen between problem-solving strategies and the student's success in solving geometry problems. In particular, it can be said that strategies such as understanding the problem, simplifying the problem and making a systematic list are effective in increasing student success. It is also important that Arsal (2016) and Altun (1995) say that problem-solving strategies do not have much effect on mathematics achievement if they do not help understanding the problem. They both talk about the importance of problem-solving strategies and say that this is important for mathematics success. However, they also say that this is not a very important point for solving the problem. Because, according to them, it is a critical point that Polya (1957), who gave the algorithm of problem solving stages, said that the first step in solving a problem is of course understanding the problem. For this reason, they emphasize that a strategy that does not help understand the problem is not useful in solving the problem. Baykul (2002) supports this view by stating that the first step in solving a problem is to understand what the problem is and finding what is desired by understanding the information given, and that this is a prerequisite for reaching the solution.

Although there are various opinions between mathematics achievement and problem-solving strategies, the findings of the research generally show that these strategies facilitate the solution of problems. This situation can be considered as an obvious fact.

Result and Suggestions

Research results show that the most commonly used problem-solving strategies when solving geometry problems are prediction and verification, making a systematic list, drawing shapes, simplifying the problem, working backwards, and finding relationships and patterns. These strategies develop students' mathematical thinking skills, structure the problem-solving process, and enable students to solve geometry problems more effectively. However, it is seen that problem-solving strategies positively affect student success and contribute to the development of mathematical literacy. According to the research results, the following suggestions can be offered within the scope of the subject:

- More emphasis should be placed on problem-solving strategies in teaching geometry and students should be taught how to use these strategies.
- Textbooks and curricula should include more problems focusing on problem-solving strategies and allow students to apply these strategies.
- Teachers should give students the opportunity to use problem-solving strategies through in-class activities and assignments and encourage the effective application of these strategies.
- A variety of problem-solving tasks and exams should be used to assess students' problem-solving skills, and these assessments should focus on problem-solving strategies.

As a result, problem-solving strategies are of great importance in teaching geometry and are an effective tool to increase students' mathematics achievement and improve mathematical literacy. Therefore, more emphasis should be placed on problem-solving strategies and students should be taught how to use these strategies.

References

Altun, M. (1995). *A Study on Problem Solving Behaviors of Primary School 3rd, 4th and 5th Grade Students*. Unpublished Doctoral Thesis. Hacettepe University Social Sciences Institute, Ankara

Altun, M., & Arslan, Ç. (2006). A study on primary school students learning problem solving strategies. *Uludağ University Faculty of Education Journal, 19(1), 1-21.*

Altun, M., Memnun, D. S. and Yazgan, Y. (2007). Classroom Teacher Candidates' Skills in Solving Non-Routine Mathematical Problems and Their Thoughts on This Subject. *Elementary Education Online, 6 (1), 127-143*.

Arsal, Z. (2016). The Power of Problem Solving Strategies to Predict Problem Solving Success. *Abant İzzet Baysal University Faculty of Education Journal, 9(1), 103-113*.

Aydoğdu, M., Erşen, A. N., and Tutak, T. (2014). The Effect of Material Supported Mathematics Teaching on Secondary School 6th Grade Student Achievement and Attitude. *Turkish Journal of Educational Studies, 1(3), 166-185.*

Baykul, Y. (2002). *Teaching Mathematics in Primary Education*. Ankara: Pegem Publishing.

Baykul, Y., and Aşkar P. (1987). "*Problem and Problem Solving" Mathematics Teaching*. Anadolu University Publications No: 193. Open Education Faculty Publications No: 94.

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal, 9(2), 27-40.*

Chaudhary, R. (2019), *A Study on Difficulties in Learning Geometry at Secondary Level Students*, Unpublished Master's Thesis, Tribhuvan University, Central Department of Education, Department of Mathematics Education, Nepal.

Çınar, İ. (2013). *The Effect of Problem Solving Strategies in Mathematics Class on Field-Dependent-Field-Independent Students*, Unpublished Master's Thesis, Afyon Kocatepe University, Social Sciences Institute, Department of Educational Sciences, Afyon.

Gelbal, S., (1991). Problem solving. *Hacettepe University Faculty of Education Journal, 6, 167-173.*

Karakeçe, B. (2021). *Secondary School Mathematics Teachers' Evaluations on Skill-Based Questions*, Unpublished Master's Thesis, Gaziantep University, Institute of Educational Sciences, Gaziantep.

Kelly, J., and Ladd, E. (1986). *Fundamental Mathematical Structures of Geometry*. New Delhi Eurasia publishing House Pvt. Ltd, Ramnagar.

O'leary, Z. (2004). *The Essential Guide to Doing Research*. London: Sage Publications Ltd. p.177.

Özkan, U. B. (2019). *Document Review Method for Educational Sciences Research*. Ankara: Pegem Akademi, 4.

Özsoy, G. (2005). The Relationship Between Problem Solving Skills and Mathematics Achievement. *Journal of Gazi Faculty of Education, 25;(3),179-190.*

Polya, G. (1957). *How to Solve it?* Princeton, NJ: Princeton University Press.

Temel, H. (2018). *Classification of Problem Solving Strategies According to Mathematical Process Skills*, Unpublished Doctoral Thesis, Bursa Uludağ University, Institute of Educational Sciences, Department of Primary Education, Bursa.

Tutak, T., İlhan, A., İç, Ü. and Kılıçarslan, S. (2018). The Effects of Computer Aided Mathematics Teaching on Pre-service Mathematics Teachers' Views on Learning Processes. *Journal of Turkish Studies, 13(27), 1509-1524., Doi: 10.7827/TurkishStudies.14341*

Yaprak, H. (2019). *Examination of 7th Grade Students' Visualization Processes in Solving Geometric Problems*, Unpublished Master's Thesis, Dokuz Eylül University, Institute of Educational Sciences, İzmir.

Yıldırım, D. (2015). *Examination of Secondary School Students' Mathematical Thinking Processes in Geometry Problems*. Unpublished Master's Thesis, Anadolu University, Institute of Educational Sciences, Eskişehir.

COGNITIVE-BEHAVIORAL AND CONSTRUCTIVIST APPROACH IN MATHEMATICS EDUCATION

Ebru Korkmaz[1], Merve Çağlayan[2]

Abstract

This study was conducted to understand the cognitive, behavioral and constructivist approaches in mathematics education and to examine and interpret these approaches in terms of mathematics education. In this study, articles and theses in Dergipark and Google scholar, National Academic Network and Information Center, YÖK THESIS databases were examined and analyzed using the descriptive analysis method. In this study, all three theories are explained separately and information and suggestions are given about how they can be integrated into mathematics education. As a result, when we look at mathematics teaching in terms of these theories, it has been seen that in order to make teaching more efficient and permanent, approaches and theories in which the student is generally centered and made more active, and teaching is made more concrete, should be used in mathematics teaching.

Key Words: Learning theories, cognitive approach, behavioral approach, constructivist approach, mathematics education.

Introduction

Mathematics education plays an important role in raising individuals who can think critically, creatively, multi-faceted, solve problems and make healthy decisions when necessary, as required by today's conditions. Educational programs have an important place in increasing the quality of mathematics education.

Educational programs, which form the basis of education systems, contain the answer to the question of what kind of person will be raised (Yüksel, 2003). A lot of information about the competencies that the individual is expected to have, from teacher training to the textbook, from the classroom

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method to the teaching method to be applied, can be found in the implemented programs (Akbaba, 2004).

Mathematics is a system that develops logical thinking and helps us understand our immediate environment and the world. Mathematics consists of structures and relationships, and these structures are created through a process of successive abstractions and generalizations. This system, created mentally by people, shows that mathematics is abstract and it is difficult to acquire abstract concepts (Baykul, 2009).

Constructivism emphasizes a paradigm that transforms from education based on behaviorism to education based on cognitive theory. Behaviorist theory of knowledge; intelligence focuses on the field of goals, the level of knowledge and strengthening it (Collay & Gagnon, 2001; Şahin, 2007). The aim in the traditional approach is; The plan made is to give formulaic knowledge within a teacher-centered approach, depending on the determined targets, that is, a curriculum (Kabaca, 2002). Constructivism is a process of interpretation. Every student, like a teacher, takes information from different sources and reconstructs it to understand. As for the implications of this theory regarding instructional design, learning is done on a performance-based basis. Performance is also the basis in evaluation. It is process based. The teacher's duty in the classroom is guidance (Şahin, 2007). The teacher is the person who facilitates and helps carry out interaction between individuals. In the learning environment, students' interest is at the forefront and primary source information is generally used. The prior knowledge that students bring to the learning environment is important for structuring later knowledge (Fer and Cırık, 2007).

Aim

The aim of this study is to explain learning theories, which are the frameworks into which research findings and practices regarding learning are placed, on the basis of mathematics education.

Method

In this research, behaviorist learning theories, cognitive learning theories, constructivist learning theories were investigated and presented on the basis of mathematics education. The literature review method was used as the method in this research. In the literature review, works such as previously published books, articles, theses, conference proceedings, historical records and reports related to the research topic are searched, found and examined, and thus, it is tried to obtain information that will contribute to the study. The purpose of the literature review can be briefly expressed as obtaining the information needed about the research (Bourner, 1996).

Data Collection Tools

In accordance with the purpose of the research, articles and theses related to cognitive, behaviorist and constructivist theories were scanned in detail from YÖK TEZ and ULAKBİM databases. In this process, current and past studies on the subject were systematically examined in line with the determined keywords and criteria. The data collection process aims to increase the scope and depth of the research.

Analysis of Data

In this research, descriptive analysis method was chosen to analyze the data obtained. This method allows the data to be restructured and evaluated from different perspectives in accordance with the research problems (Şimşek and Yıldırım, 2003).

Findings

Behaviorist Learning Theories:

Behaviorist theory is an approach that emerged in the early 20th century and started with the work of Ivan Pavlov in Russia and Edward Thorndike in the United States (Öztuna, 2002). "In the classical conditioning theory developed by Pavlov, learning is a gradual process achieved objectively through contiguity and repetition between stimulus and response. Pavlov further advanced his studies with some studies on animals. Thorndike, on the other hand, viewed learning as a problem-solving event and determined that one of the various trial-and-error behaviors performed in a problem situation led to a solution. Like Thorndike and Pavlov, he developed his studies on animals and revealed the laws of exercise and effect (Fidan, 1996).

Behaviourists accept that learning develops by establishing a bond between stimulus and behavior and that behavior change occurs through reinforcement. "Behaviorists argue that people generally consider similar situations they have experienced in the past when solving the problems, they encounter. When faced with a new problem, it is accepted that the individual will produce new solutions through trial and error. What is important in behavioral approaches are behaviors that can be observed, have a beginning and an end, and therefore can be measured. Behavioral approaches; It is accepted that it mostly explains the learning of psychomotor behaviors (Özden, 2003). It can be said that behaviorist learning theories focus on observable behaviors. The observation that in some cases the principles of the behaviorist approach cannot explain some events has led psychologists to redefine human learning. Thus, cognitive learning theories began to gain importance. Senemoğlu (2004) defines cognitive learning as the change in the mental structures of the individual. In addition to the observable behaviors discussed by behaviorists, cognitive theorists are also interested in what goes on inside the learner's head, that is, their internal structure.

"In teaching based on behavioral theory, the cycle of determining student characteristics, determining needs, writing behavioral goals, presenting the content, giving absolute evaluation and feedback (reinforcers) is generally followed. For this purpose, the characteristics and learning needs of the target student population are determined by program developers or instructional designers before teaching, then goals are created, the content covering what students need to know/do in order to achieve these goals is determined, and then the determined content is delivered in the most effective and efficient way through which medium. It is decided which method will be presented, and finally, it is determined how and with what tools the learning outcomes will be evaluated (Deryakulu, 2000).

According to Sönmez (2004), the learning principles of behaviorist theory can be listed as follows:

- "Student learns by doing. So, whatever he does, he learns. For this reason, the student should actively participate in the teaching environment.
- Repetition is of great importance in learning. A person learns some information and especially skills by repeating. Repetition strengthens the link between stimulus and behavior.
- In general, correct behavior should be reinforced. Some advocate punishment. However, the opinion that "giving positive reinforcement is more effective in producing the correct response" is predominant. Because punishment has negative aspects.
- Motivation significantly affects learning. Therefore, motivational conditions must be adjusted consistently.
- The acquired behaviors related to generalization and discrimination must be learned and used in a wide variety of situations; Because the validity and reliability of the behavior acquired as a result of this type of learning increases."

Cognitive Learning Theories:

"Cognition is related to the word "knowing" used in everyday speech. Cognition is a broad term in psychology that includes thinking and learning. Cognition is all the operations carried out by the human mind to understand the world and the events around the person. Perceiving external stimuli, comparing them with previous information, creating new information, testing and remembering the information obtained, and evaluating mental products in terms of quality and logic are activities related to mental processes that fall within the scope of cognition (Erden and Fidan, 1998).

Cognitively, learning is defined as the change in the mental structures of the individual. According to Senemoğlu (2004), this change enables the individual to change his or her behavior or acquire new behaviors. Cognitive theorists, unlike behaviorists, are interested in what goes on inside the learner's head, internal processes. That is, learning is not explained only in a stimulus-response connection. Learning is mostly the product of intelligence.

Contrary to the behavioral approach, cognitive theories focus more on the way information is perceived by the individual, the mental processes it goes through in memory, and how the information is created, rather than the way it is acquired. According to cognitive theory, learning occurs by processing information individually by the learner, establishing interest in previous experiences, and recording what has been learned in long-term memory (Aydoğdu and Tutak, 2017). Accordingly, unlike the behaviorist approach, which argues that the individual passively receives the information presented, cognitive theory argues that the individual is active in learning.

"According to the cognitive approach, the event that the behaviorist approach defines as a change in behavior is actually the external reflection of the learning that occurs in the person's mind. The development of mental activities that enable an individual to understand and learn the world around him is called cognitive development. Cognitive development is the process by which the individual's ways of understanding the environment and the world become more complex and effective, from infancy to adulthood (Güven, 2004).

According to cognitive theories, learning is a lifelong mental process that cannot be observed directly. According to this theory, it is not sufficient to explain learning only with stimulus-response correlation and conditioning. According to Sönmez (2004), mental activities such as "knowing, comprehending, sensing" are more dominant in learning. Learning is the product of both intelligence, motivation and transfer.

According to Ormrod (1990), the basic principles on which the cognitive approach is based can be listed as follows:

- "Some learning processes may be unique to humans. Based on this assumption, all cognitive research is conducted on humans.
- Mental events are the focus of research.
- The study of human learning should be objective and scientific.
- Individuals actively participate in the learning process.
- Learning involves the formation of mental connections that do not require reflection in behavioral changes.
- Information is organized.

- Learning is the process of associating new information with previously learned information."

Constructivist Learning Theory:

"The world is constantly changing; It needs individuals who are aware of the innovations and developments resulting from this change, and who can also understand their duties during this change. The developing world has become an increasingly consuming society, and an individual equipped with correct information is not enough for this society to keep up with the contemporary world. It is aimed for the individual to synthesize information in his own way and produce new information rather than consuming information" (Şaşan, 2002).

According to Demirel (2000), constructivism is not a theory about teaching, but a theory about knowledge and learning. This theory is based on establishing knowledge from the ground up. According to Perkins (1999), learning essentially means structuring knowledge and putting it into practice.

"The term constructivism refers to the construction of knowledge by the student. Each student constructs meaning individually and socially while learning it. What is called learning is this process of making sense or structuring. Constructivism describes the construction of knowledge and experience by the student. Essentially, what we call learning is this process of making sense" (Özden, 2003).

According to another definition, constructivism is the method in which people create their own knowledge and mental models as a result of their own experiences and thinking (Titiz, 2005). According to Taşpınar (2005), constructivism is not a teaching method, but a theory about the formation of learning. In other words, it is the answer to the question "how do people learn?"

According to Ülgen (1994), constructivism is a decision-making process formed by the learner's own abilities, interests, motivations, beliefs, attitudes and experiences. The individual is selective, constructive and active during learning.

The aim of the constructivism approach is not to predetermine what learners will do, but to give individuals the opportunity to direct learning in line with their own wishes with tools and learning materials (Erdem, 2001).

Constructivist education system is based on associating what is learned in class with daily life and turning it into experience. "In order to adopt the constructivist system, students must have a good understanding of some basic concepts in the system. The most important of these basic concepts are knowledge and manners. "Students should have learned that in the education system, teaching means knowledge and education means manners, and that these are very important and necessary for the development of people, society and the environment, and for individuals to communicate with each other" (Coşkun and Çetin, 2007).

It is more important for the student to be able to adapt the information he/she has learned at school to real life than to memorize certain pieces of information. The constructivist approach requires teachers to constantly analyze both their curriculum and their teaching methods, rather than seeing curriculum as fixed, unchanging structures and themselves as transmitters of knowledge. "The constructivist learning approach fundamentally differs from the traditional approach to education. The aim of this approach is for the person to take an active role in assimilating the information and placing it in his/her own mental schemas" (Özden, 2003).

The most important feature of constructivist education is that it allows learners to structure, interpret and develop knowledge. According to Şaşan (2002), "In the traditional method, the teacher transfers the information or the students can obtain it from books or other sources. "Receiving information does not mean structuring information; when the learner encounters new information, he uses his pre-existing schemas to describe and explain the world or creates new rules to explain and name the information he has received."

According to Saban (2005), views on constructivism can be summarized as follows:

- "Learning is not a passive process of reception, but an active process of creating meaning.
- Learning involves conceptual change. Learning is the restructuring of previous understandings of various concepts to make them more complex and more valid.
- Learning is subjective. Learning is the internalization of what an individual has learned through various symbols, metaphors, images, graphics or models.
- Learning is situational and shaped by environmental conditions. Instead of doing exercises, students learn to solve problems that are similar to the problems they encounter in real life.
- Learning is social. Learning develops through individuals' interactions with others to share perspectives, exchange information, and solve problems collaboratively.
- Learning is emotional. Mind and emotion are interrelated. Therefore, the nature of learning is influenced by; the individual's views and awareness about his or her own skills, clarity of learning goals, personal expectations and motivation.

- Learning is developmental and is directly related to the social, physical, emotional and mental development of individuals.
- Learning is student-centered.
- Learning is continuous. "Learning does not start and stop at a certain place or time, on the contrary, it continues continuously."

There are certain reasons why the constructivist approach attracts great attention today. According to Özden (2003), these reasons can be listed as follows:

- "It aspires to meet the need for innovation in the face of failure of currently applied methods.
- It advocates a transition from a teacher-centered approach to a student-centered approach.
- It saves students, teachers and school administration from many unnecessary bureaucratic procedures.
- It argues that knowledge can only be structured by individuals themselves."

Result

While the behavioral approach emphasizes the role of the teacher in information processing, the cognitive approach gives the learner the role of an active participant in the learning function. In the cognitive approach, the amount of learning depends on both how the teacher presents the material and how the student processes it. The role of the teacher is different for both approaches. Behaviorists; It sees teachers as authorities whose primary duty is to shape student behavior and make educational decisions that directly affect student activities. Cognitivists, on the other hand, see the teacher more as a person who helps, facilitates and mediates students in choosing appropriate learning strategies, ensuring their understanding and making decisions for their future learning. For cognitivists, one of the major goals of education is to help students control and manage their learning.

The new understanding in mathematics education highlights mathematics by doing mathematics instead of just learning mathematics (Olkun and Toluk, 2003). The vision of the renewed primary school mathematics program; To raise individuals who can use mathematics in their lives, solve problems, share their solutions and thoughts, and enjoy learning mathematics. This program, prepared with the principle of 'Every child can learn mathematics', follows a conceptual approach. With this approach; In addition to the development of mathematical concepts, it is also aimed to develop operation skills and some important skills. These skills; problem solving, communicating, reasoning and relating. Concepts related to mathematics are abstract in nature. Considering the developmental levels of children, it is quite difficult to acquire concepts directly. Because; Considering the concepts based on concrete and finite life models will enable students to realize that mathematics is an indispensable tool in daily life and to develop a positive attitude towards mathematics (MEB, 2005).

"The purpose of constructivist learning is to provide learning opportunities for learners to mentally make sense of the information. Since the knowledge of learning individuals varies, two individuals may attribute different meanings to the same concept, instead of a single truth in constructivism. Therefore, goals cannot be determined precisely. There are only general goals that students are expected to achieve. Behaviors are more generally included in goal statements" (Hollaway, 1999).

Curriculum designs based on constructivist learning deal with the question of "how individuals learn" rather than the question of "what to teach". According to Ülgen (1994), constructivist designers begin program development with a study that will help individuals reveal their existing knowledge. Goals are determined by the joint decision of the teacher and the student. Participating students in these decisions increases the learner's desire to achieve the goal. In line with this information, the main goal of the constructivist approach is; It can be assumed that the aim is to raise productive individuals who research, learn, internalize what they learn, analyze, question, and offer solutions to the problems they encounter.

Suggestions

- Students should be made aware that mathematics is a part of life,
- The subjects taught should be given meaning,
- Concept maps should be included in mathematics teaching,
- In teaching mathematics, subjects should be associated with daily life and presented using visual stimuli,
- Considering the relationship of mathematics with other disciplines, students should be directed to make observations and research,
- Only blackboard and chalk should not be used in mathematics teaching,
- Methods and activities in which the student can be active should be preferred,
- Technological tools should be used in mathematics teaching.

In order to successfully implement the new mathematics program, the following teaching strategies must be taken into account in the learning-teaching process:

- Teaching should begin with concrete experiences.
- Meaningful learning should be aimed.
- Students must communicate their mathematical knowledge.
- Association should be taken seriously.
- Student motivation should be taken into account.
- Technology should be used effectively.

References

Akbaba, T. (2005). Program development studies during the Republic period. *Journal of Education in the Light of Science and Mind, 54-55,*

Aydoğdu, M. and Tutak, T. (2017). Developing Mathematical Modeling Activities for Secondary School 8th Graders. *The Journal of Academic Social Science (54), 155-166.*

Baykul, Y. (2009). *Teaching Mathematics in Primary Education 6-8. Classes*. Ankara: Pegem Publishing.

Bourner, T. (1996). *The research process: Four steps to success. Greenfield*, T. (Ed.), Research methods: guidance for postgraduates (pp. 7-11). London: Arnold.

Coşkun, V. and Çetin, D. (2007). *Teacher-Guidebook Relationship in the Constructivist Learning Process*. IV. New Trends in Education Symposium,

Creswell, J. W. (2007). *Qualitative inquiry & research design: Choosing among five approaches* (2nd Edition). USA: SAGE Publications.

Çağlar, G. (2010). *The effect of constructivist approach on mathematics teaching (in 7th grades of primary education)* (Unpublishing Master's thesis, Institute of Social Sciences).

Demirci, A. (2014). Literature review. Geographical research methods, 73-108.

Demirel, Ö. (2000b). *The Art of Teaching, from Planning to Assessment* (2nd Edition). Ankara: Pegem-A Publications.

Deryakulu, D. (2000). *Constructive Learning*. Ankara: Eğitim-Sen Publications.

Erdem, E. (2001). *Constructivism Approach in Curriculum Development*. Unpublished Master's Thesis, Hacettepe University Institute of Social Sciences.

Erden, M. and Fidan, N. (1998). *Introduction to Education. Ankara*: Alkım Publishing House.

Fer, S. and Cırık, İ. (2007). *Constructivist Learning from Theory to Practice*. Istanbul: Morpa Culture Publications.

Fidan, N. (1996). *Learning and Teaching in School*. Istanbul: Alkım Publishing House.

Gülten, D. Ç., Ergin, H., & Recep, A. V. C. I. (2009). The impact of information processing theory and meaning making on mathematics teaching. *HAYEF Journal of Education, 6(2), 1-10.*

Güven, M. (2004). *The Relationship Between Learning Styles and Learning Strategies*. Publication No: 18, Eskişehir: Anadolu University Faculty of Education Publications.

Hollaway, J.C. (1999). Constructivism Ahead. Educational Leadership, November.

İlhan, A., Tutak, T., İç, Ü. and Ekinci, N. (2020). Examining the Opinions of Mathematics Teacher Candidates About the Special Teaching Methods Course. *Electronic Journal of Social Sciences, 19(73), 156-170.*

Kabaca, T. (2002). *A Learning and Teaching Approach: Constructivism*. 02.May.2013; http://tolgakabaca.pau.edu.tr/dokumanlar/CONS_ODEV.pdf.

MEB. (2005). *Primary education 1-5. Classroom Programs Promotion* Handbook, Ankara: State Books Directorate Printing House.

Ocak, G., & Ateş, F. Ç. (2015). Evaluation of the applicability of the constructivist approach in secondary school mathematics courses in terms of teachers' opinions. *International Journal of Field Education, 1(2), 1-23.*

Olkun, S. and Toluk, Z. (2003). *Activity-Based Mathematics Teaching in Primary Education*, Ankara: Anı Publishing,

Olkun S, Toluk Uçar Z (2018). *Activity-based mathematics teaching in primary education*, Ankara: Vizetek publishing, p:1-24

Ormrod, J.E. (1990). *Human Learning: Theories, Principles and Educational Applications*. Columbus: OH Merrill.

Özden, Y. (2003). *Learning and Teaching*. Ankara: Pegem-A Publishing.

Öztuna, A. (2002). *The Effect of Structuring Concept Maps in the Group Cycle on Success and Concept Development*. Unpublished Master's Thesis, Marmara University Institute of Educational Sciences.

Perkins, D.N. (1999). *The Many Faces of Construct*ivism. Educational Leadership, November.

Saban A. (2005). *Learning and Teaching Process*. Ankara: Nobel Publications.

Senemoğlu, N. (2004). *Development Learning Teaching: From Theory to Practice* (9th Edition). Ankara: Gazi Bookstore.

Sönmez, V. (2004). *Teacher's Handbook in Curriculum Development*. Ankara: Anı Publishing.

Subaşı, M., Okumuş, K. (2017). Case Study as a Research Method, *Atatürk University Social Sciences Institute Journal, 21 (2): 419-426.*

Şahin, Ü. (2007). *Perceptions of Primary School First Stage Classroom Teachers About the Mathematics Curriculum Prepared Based on Constructivist Approach (Denizli Province Sample).* Unpublished Doctoral Thesis. Pamukkale University, Denizli.

Şaşan, H.H. (2002). Constructivist Learning. *Journal of Living Education, 74(75), 49-52.*

Şimşek, H. and Yıldırım, A. (2003). *Qualitative research methods in the social sciences*. Ankara: Seçkin Publishing.

Taşpınar, M. (2005). *Teaching Methods from Theory to Practice*. Ankara: Nobel Publishing.

Titiz, O. (2005). *New Teaching System.* Istanbul: Zambak Publications.

Ülgen, G. (1994). *Educational Psychology: Concepts, Principles, Methods, Theories and Applications*. Ankara: Laser Offset.

Yuksel, S. (2003). Program development studies and problems in Turkey. *National Education Journal, 159.*

USING THE HISTORY OF MATHEMATICS IN MATHEMATICS EDUCATION

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Abstract

Today, the biggest obstacle to teaching mathematics is negative attitudes and beliefs towards the lesson. This situation is a big problem for both the teacher and the learner. When students learn mathematics, they ask, "Why am I learning this? ", "How will this issue be useful to me? They make inquiries like ". We can answer questions such as how mathematics is used in real-life situations and how mathematics emerged in the past, etc., by using the history of mathematics. We can say that the use of the history of mathematics in mathematics education begins exactly here. The purpose of this study is to talk about the importance of using the history of mathematics in mathematics education and to emphasize that it has a positive impact on students' attitudes towards the course.

Key Words: History of Mathematics, Mathematics Teaching, Attitude, Mathematics Education

Inroduction

Mathematics is a branch of science that is inherently complex. Since it is more abstract in nature than other branches of science, students have difficulty in understanding it. For this reason, eliminating students' negative attitudes towards this complex course and ensuring that they enjoy the course is an important issue in terms of learning mathematics (Altun, 2006; Altun, 2008). Various methods are used to help students develop positive attitudes towards mathematics and to make the lesson more interesting. One of these is to benefit from the history of mathematics in mathematics teaching. History of mathematics is a science that explains the development of mathematics throughout history. It also gives information about the work and lives of

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mathematicians. It can also be said that it is used to solve the problems we encounter in daily life (Baki, 2008; Yıldız, 2013). The National Council of Teachers of Mathematics (NCTM), an important organization for mathematics education founded in 1920, also talked about the importance of the history of mathematics in terms of mathematics teaching.

It has been observed that it is included in a certain scope in the curriculum published by the Ministry of Education. It has been examined that this scope is gradually narrowing. In the 2005 program, the statement "He will be able to understand the historical development of mathematics and its role and value in the parallel development of human thought and the importance of its use in other fields" is stated. In addition, the history of mathematics is mentioned under the title of the project proposal. These are titles such as "mathematics in different cultures", "historical development of mathematics", "life of scientists who contributed to mathematics", "history of mathematical games" (MEB, 2005). In the most current 2018 program, only the 3rd grade level objective "Reads and writes Roman numerals up to 20" is included. In the explanation of the outcome, it was requested that the number symbols used by ancient civilizations be introduced with examples from the history of mathematics in order to attract students' interest in mathematics (MEB, 2018).

When curricula from past to present are examined, it is seen that the sections on the history of mathematics are very few and insufficient. History of mathematics can be used more and associated with more subjects, thus providing more efficient mathematics teaching (Başıbüyük, 2012).

Purpose of the Research

The aim of this study is to examine the effect and contribution of using the history of mathematics in mathematics education. It is explained how much the history of mathematics is integrated into mathematics education and how sufficient this is. In particular, it is to reveal that the method of using the history of mathematics in mathematics education has a positive impact on students while learning mathematical concepts and information. In addition, it has been researched how to use the history of mathematics more effectively in mathematics education and how mathematics education can be enriched in this regard.

Research Method

In this study, the use of history of mathematics in mathematics education was examined. He used the literature review method for the research. Literature review is to examine the research studies that have been done on the subject. In this process, academic literature, mathematics curriculum and mathematics textbooks were scanned.

Studying Group

The sample of the research consisted of articles and theses on mathematics education and history of mathematics through the resources of the Council of Higher Education Thesis Center (YÖK TEZ) and the National Academic Network and Information Center (ULAKBİM).

Data Collection Tool

For the purpose of the research, articles and theses on mathematics education and history of mathematics were scanned in YÖK TEZ and ULAKBİM databases.

Analysis of Data

In the research, a literature review was conducted on the use of the history of mathematics in mathematics education and the descriptive analysis method was chosen to analyze the data obtained. Descriptive analysis was used to guide the target audience in their own studies by organizing the findings on the subject (Yıldırım and Şimşek, 2018).

Findings

Mathematics Education

One of the main goals of mathematics education is to raise individuals who have high problem-solving skills, adopted a mathematical thinking style, high reasoning skills, in short, mathematical competence (MEB, 2018). It is aimed for individuals not only to learn the mathematical knowledge and skills they have, but also to transfer them to different areas of life and thus direct the flow of life.

In short, it is desired to raise people who have made mathematical thinking a philosophy of life (NCTM, 2000). In order to achieve this target, students must first love and embrace mathematics and reduce their anxiety towards mathematics. For this, they must have a positive attitude towards mathematics. One of the special aims of the Mathematics Curriculum is "He will develop a positive attitude towards mathematics with his experiences in learning mathematics and develop a self-confident approach to mathematical problems." It is also stated in the article (MEB, 2018).

In this context, various methods can be used to make students enjoy mathematics lessons and have a positive attitude. One of these is to integrate the history of mathematics into mathematics education to make the course more interesting and to emphasize the necessity of mathematical science. Using history of mathematics in mathematics teaching will not only help students look at mathematics from a broader perspective, but will also contribute positively to solving the problems they encounter and broadening their perspectives on these problems (İdikut, 2007; Özcan, 2014).

Integrating the History of Mathematics into Mathematics Education

While learning mathematics, students ask "Why are we studying this subject?" "Where will this issue be useful to us?" We may be subjected to similar questions such as: With the answers we give to these questions, we can attract students' attention and at the same time contribute to changing their perspectives on mathematics. By talking about where and how people used mathematics in the past, we can positively influence their attitudes towards the course and help them understand the need and importance of mathematics (Baki, 2008).

When teaching mathematics, we have to make the lesson more interesting and show that mathematics is not just a collection of rules. In this context, we can talk about important people and events in the history of mathematics. Thus, we can make the subject we are talking about interesting and meaningful. At the same time, we can attract the attention of students who are bored and disconnected from the lesson and teach a more productive lesson (İlhan and Tutak, 2021). As an example, we can give an example of the learning outcome "Explains the contributions of Atatürk's works in the field of geometry to geometry teaching in our country" in the 5th grade geometry learning field in the 2013 curriculum. Students' learning that our great leader, the founder of our country, also wrote a geometry book will be beneficial in changing their perspective on mathematics (MEB, 2013).

In the 8th grade geometry learning area of the curriculum, while teaching the achievement of "Creating the Pythagorean relation and related problems", the life of Pythagoras can be mentioned and even interesting and intriguing information can be given to the students by linking the first crisis of mathematics with the discovery of irrational numbers. While explaining the topics during the learning process, the narrative can be enriched by making connections with the history of mathematics. To give other examples, we can mention the Father of Algebra, Khwarezmi, when talking about algebraic expressions, the birth of mathematics, or the pyramids of the Egyptians and the calculation of the flood time of the Nile River when talking about numbers. Stories about mathematics from ancient civilizations like these can be told, and this will change students' preconceived notions about mathematics (Clark & Thoo, 2014; Fried, 2007; Furinghetti, 2004; Heide, 1992; Mann, 2011).

Considering all these examples, the use of the history of mathematics in mathematics education provides motivation while learning mathematics and makes it easier to understand these concepts while learning how mathematical concepts were born and how they developed. At the same time, it reduces anxiety and fear towards mathematics and guides teachers on why students have difficulty in mathematics today (Fauvel, 1991).

Approaches to Using the History of Mathematics in Mathematics Education

It is thought that the purpose of using history of mathematics in mathematics teaching will be beneficial in that it can eliminate negative attitudes and judgments towards mathematics lessons. It will make learning mathematics interesting and at the same time provide the student with the necessary motivation while studying mathematics. In addition, approaches have been developed on how the history of mathematics can be integrated into mathematics teaching. The history of mathematics has focused on the idea of whether it is a goal or a tool in teaching mathematics.

According to Bidwell (1993), history of mathematics can be used as a tool in teaching mathematics. We can use it as a tool in the course by talking about the rich history of mathematics, historical elements, famous mathematicians, and the development of mathematics. In this way, it positively changes students' perception of mathematics as unnecessary lessons and helps them learn mathematics better (Limm, 2011). When used as a purpose, it can be said that it enables students to understand the history of mathematics and important events and facts in the history of mathematics (Başıbüyük, 2012; Jankvist, 2009).

Jankvist (2009) put forward three approaches regarding the use of history of mathematics in mathematics education. These are the illumination approach, module approach and date-based approach. The enlightenment approach is about including historical events, problems and people related to mathematics in teaching mathematics. The module approach is to present historical processes to students by creating modules. Various materials can be used in these modules. The history-based approach, on the other hand, deals with the examination of the history of mathematics indirectly, rather than directly (Jankvist, 2009).

Bidwell (1993) and Swetz (1994) talk about the use of history of mathematics in mathematics teaching: "the work and experiences of mathematicians who shed light on history", "identifying historical problems and doing activities related to them", "using visual materials such as short films and videos", "topic narration". or using the historical development process during problem solving", "introducing the roots of mathematical symbols, terms and concepts", etc. They mentioned many ways.

Fried (2001) mentioned that the history of mathematics can be used in two different ways in lessons: addition and harmony. In lessons, the addition method is used by explaining the historical parts of the subjects and the life of the mathematician related to the subject or by mentioning historical problems. In the adaptation method, the content of the subject is adapted to a historical scheme. While teaching the subject of mathematics, the teacher uses the historical development of the subject as a guide (Fried, 2001).

Including the History of Mathematics in Textbooks

There are statements in the curriculum about the use of history of mathematics in mathematics teaching. Textbooks serve as a guide for the teacher and are one of the learning resources for the students. In this respect, it is very important that the history of mathematics is included in textbooks. With the history of mathematics included in textbooks, teachers will be able to easily integrate the history of mathematics into the course thanks to this resource that serves as a guide (Avital, 1995; Fried, 2001).

When we scanned all published curriculums, various contents were presented about the use of history of mathematics in mathematics teaching. It was first mentioned in the 2005 mathematics curriculum. In later years, the content was expanded with various suggestions. It is aimed to focus the students' attention on the course with various suggestions such as project suggestions on the history of mathematics, explaining the subject by making use of the history of mathematics, and using visual materials in the lessons. In the 2018 curriculum, the specific objectives of the mathematics course include "They will value mathematics, being aware that mathematics is a common value of humanity." The statement emphasizes the history of mathematics (MEB, 2018). Various studies have also been conducted on whether the inclusion of history of mathematics in mathematics textbooks is sufficient or inadequate.

Erdoğan, Eşmen and Fındık (2015) examined seven different secondary school mathematics textbooks taught in the 2013-2014 academic year and twenty-seven mathematics history items were identified. As a result of the study, they stated that these elements were insufficient and that these elements were generally used to motivate students for the lesson. In addition, the elements in the books were generally used in learning areas such as numbers and geometry, whereas relatively fewer items were encountered in other learning areas. In another study, it was determined that mathematics history elements were included in historical fragments in mathematics textbooks (Baki and Tümer, 2013).

The National Council of Teachers of Mathematics (NCTM) also believes that the history of mathematics should be included in the mathematics curriculum. He stated that in this way, students' motivation and positive attitude towards the course will increase, they will understand the difficulties of learning mathematics today by realizing the obstacles to learning mathematics in the past, they will gain a perspective on mathematics by benefiting from the history of mathematics, and their mathematical thinking will improve thanks to the historical problems used in the course (NCTM, 2000).

Result and Suggestions

In this study, mathematics education and the use of mathematics history in mathematics teaching were examined. When the literature on the subject was scanned, it was seen that the use of history of mathematics in mathematics teaching was encouraged, considering the standards set by NCTM and the curriculum of the Ministry of Education.

It has been determined that students' negative attitudes and judgments towards mathematics have changed as a result of the integration of the history of mathematics into mathematics education. It has been revealed that the use of elements of the history of mathematics in lessons, mentioning mathematicians who shed light on history, and using visuals related to the history of mathematics have a positive effect. The main goal in all courses, especially mathematics, has been effective and permanent learning. Permanent learning is achieved by appealing to more than one sense (Aydoğdu and Tutak, 2017). Using the history of mathematics helps achieve lasting learning.

The materials, visuals, interesting stories and events we use support permanent learning. In addition, the effective use of the history of mathematics makes the abstract mathematics course more concrete. Dramas, games, project assignments and activities using the history of mathematics can be given as examples. At the same time, the activities we include in textbooks can serve as a guide on how the history of mathematics can be used in mathematics teaching (Avital, 1995; Fried, 2001).

Students' attitude towards the course is also very effective in meaningful and permanent learning. Students are prejudiced against the courses they dislike, have anxiety and fear about. They are not interested in the lessons they have negative feelings about and do not want to learn. Interest in the course and motivation are two of the prerequisites for learning to occur (Ocak & Dönmez; 2010). The student reveals his true learning potential while learning what he is interested in and loves. It has been shown that the history of mathematics attracts students' attention and makes them more motivated towards the course.

Although this study and all related studies show that the history of mathematics should be used more in mathematics courses, other research studies show that this use is insufficient. When we scan the Ministry of Education curricula and textbooks, it is seen that the elements of the history of mathematics are insufficient.

We also mentioned that textbooks act as guides for teachers. Including history of mathematics elements in textbooks can guide teachers regarding the use of history of mathematics in lessons. Thus, a more meaningful teaching takes place. Mathematics teachers can receive pre-service and in-service training on the history of mathematics and why and how this history should be used in education (Alpaslan, Işıksal & Haser, 2014; Fauvel, 1991).

In the light of all this information, the curriculum and textbooks that are found to be inadequate can be re-evaluated in this regard. More activities and studies on the use of history of mathematics can be included in textbooks. More guiding and encouraging phrases can be used regarding the use of history of mathematics in the curriculum. Implementation of these recommendations will facilitate the use of history of mathematics in mathematics education. In this way, students will develop positive attitudes towards mathematics. Their perspective on mathematics will change and they will learn mathematics in a more permanent way.

References

Alpaslan, M., Işıksal, M., & Haser, Ç. (2014). Pre-service mathematics teachers' knowledge of history of mathematics and their attitudes and beliefs towards using history of mathematics in mathematics education. *Science & Education, 23(1), 159-183.*

Altun, M. (2006). Advances in mathematics teaching. *Uludağ University Faculty of Education Journal, 19(2), 223-238.*

Altun, M. (2008). *Mathematics teaching*. Bursa: Current Publications

Avital, S. (1995). History of mathematics can help improve instruction and learning. Learn from the masters, 3-12.

Aydoğdu, M. and Tutak, T. (2017). Developing Mathematical Modeling Activities for Secondary School 8th Graders. *The Journal of Academic Social Science (54), 155-166.*

Baki, A. and Tümer, S. Ö. (2013). The Ways of Using the History of Mathematics in 6th, 7th and 8th Grade Mathematics Textbooks. *Primary School Online, 12(3)*

Baki, A. (2008). *Mathematics education from theory to practice*. Ankara: Letter Education.

Baki, A. & Tümer, S. Ö. (2010). Reflections from the classroom environment enriched with history of mathematics activities*. IX. In National Science and Mathematics Education Congress Abstracts (p. 104),* Dokuz Eylül University, İzmir

Başıbüyük, K. (2012). *Using the history of mathematics in teaching mathematics courses: İbrahim Hakkı perspective and the example of the Babylonian method*. Unpublished Master's Thesis, Atatürk University.

Bidwell, J. (1993). Humanize your classroom with the history of mathematics. *The Mathematics Teacher, 86(6), 461-464.*

Burns, B.A. (2010). Pre-service teachers' exposure to using the history of mathematics to enhance their teaching of high school mathematics. *Issues in the Undergraduate Mathematics Preparation of School Teachers, 4, 1-9.*

Clark, K. M., & Thoo, J. B. (2014). Introduction to the special issue on the use of history of mathematics to enhance undergraduate mathematics instruction, PRIMUS: Problems, Resources, and Issues in Mathematics Undergraduate Studies, 24(8), 663-668.

Erdoğan, A., Eşmen, E. and Fındık, S. (2015). The place of history of mathematics in secondary school mathematics textbooks: an ecological analysis. *Marmara University Atatürk Faculty of Education Journal of Educational Sciences, 42(42), 239-259.*

Eren, M., Bulut, M. ve Bulut, N. (2015). A content analysis study about the usage of history of mathematics in textbooks in Turkey. *Eurasia Journal of Mathematics, Science &Technology Education,* 11(1), 53-62.

Fauvel, J. (1991). Using history in mathematics education. *For the Learning of Mathematics, 11(2), 3-6.*

Fried, M. N. (2001). Can mathematics education and history of mathematics coexist? *Science & Education, 10(4), 391-408*.

Fried, M.N. (2007). Didactics and history of mathematics: knowledge and self-knowledge. *Educational Studies in Mathematics,* 66(2), 203-223.

Furinghetti, F. (2004).History and mathematics education: a look around the world with particular reference to Italy*. Mediterranean Journal for Research in Mathematics Education*, 3, 1-19.

Jankvist, U. T. (2009). A categorization of the "whys" and "hows" of using history in mathematics education. *Educational Studies In Mathematics,* 71(3), 235-261

Heiede, T. (1992). Why teach history of mathematics? *The Mathematical Gazette,* 76(475), 151- 157.

Idikut, N. (2007). *The effect of using history in mathematics teaching on students' attitudes towards mathematics and their mathematics achievement*. Unpublished Master's Thesis, Yüzüncü Yıl University, Van.

İlhan, A. and Tutak, T. (2021). An Evaluation of SEIE, LDE, fBEtSE and HSTE by Mathematics Teachers. *International Online Journal of Educational Sciences, 13(1), 182-193.,* Mann, T. (2011). History of mathematics and history of science. ISIS: *The History of Science Society, 102(3), 518-526.*

MEB. (2005). *Board of Education and Discipline primary school mathematics course curriculum and guide*. Ankara: Ministry of National Education.

MEB. (2017). *Board of Education and Discipline primary school mathematics course (1st, 2nd, 3rd, 4th, 5th, 6th, 7th and 8th grades) curriculum*. Ankara: Ministry of National Education.

Lim, S. Y. (2011, July). Effects of using history of mathematics on junior college students' attitudes and achievement.

Ocak, G., and Dönmez, S. (2010). Developing an attitude scale towards mathematics activities of 4th and 5th grade primary school students. *Journal of Theoretical Educational Sciences, 3(2). 69- 82.*

Swetz, F. J. (1994). Learning activities from the history of mathematics. Portland: Walch Publishing.

Yıldız, C. (2013). *Examining secondary school mathematics teachers' use of history of mathematics in their lessons: Reflections from HIE* (Unpublished master's thesis). Karadeniz Technical University, Trabzon, Türkiye.

COMPARISON OF VAN HIELE GEOMETRIC THINKING MODEL AND SOLO TAXONOMY

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Abstract

Research has revealed that students experience many difficulties in the field of geometry, which is one of the sub-branches of mathematics education. One of the things that needs to be done to correct this situation is to analyze how students perceive geometric concepts. While doing this analysis, Van Hiele Geometry Thinking Model can be used. Thanks to this model, the level the student is at can be determined and the tasks that the student is expected to fulfill can be determined. In this way, it will be easier to detect the misconceptions of students with different geometric levels and to guide them. Another model used to interpret and classify students by looking at the nature of their answers to a certain concept or problem is the Solo Taxonomy. The Solo Taxonomy provides a comprehensive framework for evaluating observable learning outcomes. These models, which we use in order to measure the cognitive dimension of mathematics education, are divided into various levels. The purpose of this study is to examine the similarities and differences between the Van Hiele Geometry Thinking Model and Solo Taxonomy levels. As a result of the literature review, it will be more useful to use the Solo Taxonomy in evaluating learning outcomes related to geometric concepts, as it has been determined according to the qualities of student answers and the level features of this taxonomy are specified in more detail.

Key Words: Van Hiele, Van Hiele Levels of Geometric Thinking, Solo Taxonomy, Levels of Solo Taxonomy

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Introduction

As technology develops day by day, countries are competing with each other in every field. The most important condition for being victorious in this race is to be successful in education. The higher the education level of a country, the higher its development level will be (Aydoğdu, et al., 2022). Mathematics education, which is directly related to growth and development, also gains importance for these reasons (Bekdemir et al., 2008).

Training programs consist of 4 basic elements:

1. Goal
2. Content
3. Learning-teaching
4. Measurement and evaluation

These elements are constantly renewed and changing. As the most basic element, the target is the first stage of the training program (Tutak, et al., 2018). This is because other elements are shaped according to the target element. Various taxonomies are used in order to classify these targets more effectively and to see the hierarchical balance between them. Classifying entities into levels from easy to difficult, adhering to the principle of prerequisites, is called taxonomy. Taxonomies move from broad targets to specific targets. Bloom Taxonomy (Bloom, 1956), Haladayna Taxonomy (Haladayna, 1997), Van Hiele Levels of Geometric Thinking (Van Hiele, 1986), and SOLO Taxonomy (Biggs and Collis, 1982) can be given as examples of some taxonomies (Ergene and Karahan, 2023). Taxonomies help us in our studies on how and what the learning objectives should be (Çetinoğlu, 2013).

This study was conducted to contribute to a better understanding of the Van Hiele Geometric Thinking Model and Solo Taxonomy and to see the similarities and differences between them.

Purpose of the Research

The purpose of this research is to examine the similarities and differences between Van Hiele, a geometry thinking model, and Solo Taxonomy, a general educational taxonomy. A comparison of the two models in terms of their usefulness to the teacher was investigated.

Research Method

In this study, Van Hiele Geometry thinking model and Solo Taxonomy were compared. The literature review method was used for the research. By examining the existing sources and documents about the subject area, a map of the research subject was created and features that could be compared were determined.

Studying group

The study sample consisted of articles in the databases of the Council of Higher Education Thesis Center (YÖK TEZ) and the National Academic Network and Information Center (ULAKBİM).

Data collection tool

Articles related to the subject of the study were accessed in YÖK TEZ and ULAKBİM databases. Data related to the study were collected and arranged in line with the criteria of the subject.

Analysis of Data

Descriptive analysis method was used to analyze the data obtained in this study. Thanks to this method, the data is presented in an understandable manner.

Emergence of Van Hiele Theory

Van Hiele Geometric Thinking Model is a model that explains how geometry is perceived by individuals. In this model, different levels are examined and how students understand geometric concepts is examined. The model was first introduced by the Dutch couple Dina van Hiele-Geldof and Pierre van Hiele. The theory is the subject of Dina Van Hiele's doctoral thesis. However, since she died after completing the thesis topic, her husband Pierre Van Hiele developed the theory (Paksu, 2016).

Realizing the difficulties students experienced while learning geometry, they decided to reveal this model. It started to be included in the curriculum of the Soviet Union since the 1960s. However, it began to attract the attention of American researchers in the late 1970s. Since these dates, three different projects have been carried out to examine the model in more detail. One of the first projects was to translate the model into English in 1984. Pierre van Hiele presented his model to the international work literature in his book titled Structure and Insight. Since these dates, the model has begun to be accepted worldwide (Paksu, 2016).

Van Hiele Geometric Thinking Model

As with every mathematical concept or operation, geometric meaning also has certain stages. These stages differ from each other according to the students' understanding styles. The successive levels seen in the model progress according to the ability to analyze the parts between the whole and then make mathematical abstract inferences based on these analyses. In other words, it has been observed that there is a development from general to specific, from simple to complex (Paksu, 2016). Even though each student is not the same age, they pass through these levels in order (Altun, 2013). The goal at one level constitutes the purpose of further study (Türnüklü, 2014).

Studies on Van Hiele Geometric Comprehension Levels have focused on the following two issues: The hierarchical structure of the levels and examining student performances with activities created according to these levels (Türnüklü, 2014).

According to Van Hiele Theory, geometric understanding is examined through 5 stages.

Level 1- Visual Level

Level 2- Analytical Level

Level 3- Informal Inference Level

Level 4 Inference Level

Level 5 Systematic Thinking Level

1.Visual Level:

The student perceives the geometric shape given to him as a whole and does not focus on the parts. For this reason, the elements that make up the shape are edges, corners, etc. can't pay attention. The student evaluates the shape only by its appearance. Rather than the features of the geometric shape, its appearance, position, size and smallness on the page are more important to the student. If the student sees the shape in subsequent views, in the same position or posture as in the first view, he or she can recognize the shape (Paksu, 2016). For the student, square is square (Gökbulut, 2010). If the teacher gave the classroom blackboard as an example while explaining the rectangle in the classroom, the rectangle is now the classroom board for the student. If asked why the classroom blackboard is classified as rectangular, the student cannot answer this. The student compares geometric shapes based on their similarities with each other, and does not take into account the formal features that make up the shape. The student names the square given to him as a square, not because of its features that all sides are perpendicular and equal to each other, but because it resembles the shape he matched with the square name given to him before (Paksu, 2016).

Activities suitable for this level can be used in the 1st, 2nd and 3rd grades of primary education (Çakmak and Güler, 2014). Similar activities can be used for concepts introduced for the first time at other grade levels (For example, the concept of cylinder in the 5th grade) (Gökbulut, 2010).

In order for the student to move from this stage to the next stage, he needs to increase his experiences with geometric shapes. Varieties around the figures used as the subject should be included frequently. Students should be given more opportunities to make observations, and environments should be prepared for them to express their thoughts (Gökbulut, 2010). When introducing geometric shapes, care should be taken to give plenty of examples. Instead of being limited to the most special or regular geometric shapes, the aim should be to ensure that shapes with different positions and sizes take a place in the student's mind (Paksu, 2016).

2.Descriptive (Analysis) Level:

With this level, the student begins to realize that, unlike the previous level, geometric shapes consist of parts and that there are properties between these parts. The student has now started to focus on the features of the shape, leaving aside the appearance of the shape. The student, who begins to understand the features between the components of the shape, cannot recognize the connection between these features and treats them independently of each other. It cannot consider the hierarchy between features. For example, understanding that a square is a special rectangle, etc. Since he cannot understand the relationship between the features in the shape, he cannot make a concise and short definition of the shape. Instead, he makes a definition in which he lists the features of the shape one after the other. Thus, the student lists more features than necessary (Paksu, 2016). The 3rd and 4th grade levels of primary education are examined in this phase (Gökbulut, 2010). Students at this level can be given activities that determine the properties of shapes, define and classify them, and create other shapes by distorting the shape. In this way, it will be easier for them to see the relationship between shapes (Paksu, 2016).

3. Informal Inference (Based on Experience) Level:

At this level, the definitions of shapes begin to make sense to students. The student begins to see the relationship between shapes. Begins to notice the hierarchy between classes. For example, one may notice that a square is a special rectangle, but that a rectangle is not a square because it does not meet the properties of a square. Once they realize the hierarchy between shapes, they can make a concise explanation when defining a concept. While counting the features of the shape, he realizes that there will be no need to make a long list. Understands that different definitions can be made rather than sticking to a single definition of geometric shape. Definitions and axioms begin to become meaningful to the student. Can make informal inferences by following the proof steps given. However, the student has not yet reached the point where he can make inferences, that is, he cannot make a mathematical deductive inference yet (Paksu, 2016).

The activities recommended for the 5th grade level of primary school are suitable for this level (Gökbulut, 2010). Students at this level should be given different shapes and made to make inferences about their features. Such activities will allow the student to prepare for the ability to prove (Paksu, 2016).

4. Inference (Formal-Logical) Level:

At this level, students begin to reason by proving within the mathematical system. Starting from previously proven theorems and axioms, they can prove other theorems and understand the axioms by using deduction. They become aware of what are the sufficient and necessary conditions when proving. When describing the features of a shape, the student begins to not feel obliged to see that shape. He can think about the concept given to him independently of the form. For example, when the concept of diagonal is mentioned, he can explain that concept without thinking of other shapes. Finally, students who have reached this level can explain the relationship between concepts in non-Euclidean geometry such as undefined terms, axioms, theorems, and postulates. But it cannot yet comprehend non-Euclidean geometry (Paksu, 2016). Generally, this level corresponds to the high school years (Gökbulut, 2010).

5. Systematic Thinking (Advanced) Level:

This level can be reached by those who deal with mathematics as a science. Those who reach here now start working on geometry as mathematicians. They can become aware of axiomatic systems. They compare theorems in different axiomatic systems. As they begin to understand non-Euclidean geometry, they begin to interpret it. They begin to formulate theorems in non-Euclidean geometry. For example, instead of Euclid's fifth postulate, which can be expressed as "Only one parallel line can be drawn to a line from a point outside it", Riemann's "A parallel line cannot be drawn from a point outside it" and Lobatchevski's "Many parallel lines can be drawn to a line from a point outside it". They can comprehend the geometries they reach with their propositions (Paksu, 2016).

The Emergence of the SOLO Taxonomy

SOLO Taxonomy, first created by J. B. Biggs and K. Colins, means "Structure of Observed Learning Outcomes" (Arı, 2013). This taxonomy serves to measure students' comprehension skills on a specific subject (Bağdat and Saban, 2014).

SOLO Taxonomy

SOLO Taxonomy, which emerged in addition to Bloom Taxonomy, assumes that learning will deepen as our knowledge on any subject increases. In addition to determining learning outcomes, it is also used in the evaluation and classification of student answers (Arı, 2013).

Since this classification was developed to cognitively measure students' comprehension levels according to a specific field, it is also quite suitable for measuring the achievements in the curriculum. The measurement and evaluation of these achievements is determined according to the nature, type and content of the answers given by the students to the questions. The answers received are examined according to the previously determined criteria to determine the student's level (Doğan, 2020). As the levels progress, students develop versatile thinking and association skills (Bağdat and Saban, 2014).

SOLO Taxonomy consists of five levels.

1. Pre-construction
2. One-way Structure
3. Versatile structure
4. Relational Structure
5. Abstracted Structure

These levels are similar to Piaget's stages of cognitive development: Sensory-motor period, Preoperational period, Concrete operational period, Abstract operational stages. The main reason for this analogy stems from the defense that mental development goes through certain stages (Doğan, 2020).

1.Pre-Structure: It is the most basic level of SOLO Taxonomy. The student does not understand the subject at all or understands it very little. It is generally very far from the subject. The answers he gives to the questions often have nothing to do with the subject (Doğan, 2020). The student uses incorrect or irrelevant methods/processes in solving the problem (Arı, 2013). The student offers ideas that are unrelated to the solution to the problem. The student's attention can get distracted very quickly while trying to solve the question. For such reasons, the student cannot fulfill the task expected of him. At the end of the teaching process, the student does not understand the subject at all or has great difficulty. When asked about their thoughts on the question, they usually receive feedback such as "I'm not sure, I don't know, I have no idea." Although the student has gained a little bit of knowledge, he is not in a position to express it (Doğan, 2020).

2. One-Way Structure: At this level, although the student has the theoretical knowledge he needs to solve the problem, he cannot reach the result. It examines the problem in question from a shallow and superficial perspective. It focuses on a single aspect of the situation it is focusing on. He cannot establish the relationship between the field he focuses on and different fields, and cannot understand the place of this field within other fields. He puts forward cognitive action in order to understand the problem sentence given to him, but this is not enough to see the whole problem (Doğan, 2020). The

student's level of understanding is low. It can only learn a certain thing (Arı, 2014).

3.Multifaceted Structure: At this level, the student begins to consider different aspects of the subject he is working on. He can make different interpretations by looking at the situations discussed from different perspectives, but cannot establish the relationship between them. He can learn correct information about a certain field, but he cannot make inferences by combining what he has learned. Although he can make explanations about the results of a situation, he cannot succeed in establishing cause-effect relationships (Doğan, 2020). It cannot determine the place of the learned concept within the whole. For example, the student can see the trees one by one, but cannot notice the forest they form (Arı, 2013).

4.Relational Structure: At this level, the student can make associations by taking into account different aspects of the situation he is working on. It can combine many parts and make them coherent and meaningful. Can realize the place of the concept in the whole. Can create a structure by bringing together various information in order to solve the problem. Can explain the reasons for this structure. He can reach new generalizations by making inferences from the results he reaches. However, at this level, the student is limited only to the information given to him/her, he/she cannot go beyond it and cannot reach generalizations by making inferences (Doğan, 2020). With this stage, the student can now understand that the forest consists of many trees (Arı, 2013).

5. Abstracted Structure: At this highest level, generalizations and classifications are made in depth. He can convey the information he has learned to different contexts and express it there by making generalizations and inferences. It can reconstruct information thanks to a high level of abstraction. He can go beyond his current learning and use reasoning beyond the data he has. In addition to answering the questions posed to him, he can search for answers by generating questions on his own. The individual at this level can make assumptions, reach generalizations, establish hypotheses, and put forward new theories (Doğan, 2020).

Comparison of Van Hiele Geometric Thinking Model and SOLO Taxonomy

Van Hiele Geometric Thinking Model aims to reveal how students at different levels perceive concepts in geometry. English, modern languages, geography, history, etc. were used in the development of SOLO Taxonomy. Since studies have been carried out in different fields such as, it has emerged as a model independent of courses and subjects. In other words, although this taxonomy is independent of the contents, it is a general educational taxonomy suitable for use in different disciplinary fields. While it was developed as the

Van Hiele Geometric Thinking Model, the SOLO Taxonomy was developed as a general cognitive development model.

While the Van Hiele Geometric Thinking Model is divided into stages according to their ability to understand geometry, the Solo Taxonomy is divided into stages depending on the nature of the answers given by the students. A student at the visual level, which is the first level of the Van Hiele Geometric Thinking Model, is asked “What is a rectangle?” When this is said, a shape may appear before your eyes. In the pre-structural period, which is the first level of the SOLO Taxonomy, the student is not interested in the question given to him or he simply answers the question.

At the analysis level, which is the second level of the Van Hiele Geometric Thinking Model, the student can list the features of a given geometric shape, but cannot see their relationship with each other. Likewise, in the one-way structure phase, which is the second level of the SOLO Taxonomy, the student examines the problem given to him from a narrow perspective and cannot notice the relationship between the problem and other parts.

In the informal inference phase, which is the third level of the Van Hiele Geometric Thinking Model, the student begins to see the relationship between the properties of geometric shapes and realizes the hierarchy between classes. But he cannot make logical inferences yet. In the multifaceted structure phase, which is the third level of the SOLO Taxonomy, the student can start to look at the problem he is working on from multiple perspectives. But he cannot see the mutual relationship between them. The 3rd level, where the student begins to see the relationship in the Van Hiele Geometric Thinking Model, begins to show itself at the 4th level, the relational structure phase, in the SOLO Taxonomy. At this level, the student begins to establish relationships between concepts and can determine the place of the concept in the whole. Just like in the informal inference phase, which is the third level of the Van Hiele Geometric Thinking model, the student cannot reach generalization by making inferences in this phase.

In the logical inference stage, which is the 4th level in Van Hiele’s Geometric Thinking Model, the student can prove using proven theorems. In SOLO Taxonomy, making in-depth investigations and generalizations about the subject being studied and being able to apply the obtained data to other situations occur at the 5th level, the abstracted structure phase.

Those who deal with mathematics as a science can reach the systematic thinking stage, which is the last level of the Van Hiele Geometric Thinking Model. Although high-level mathematicians take part in this stage, a successful student can also reach the abstracted structure stage, which is the last level of the solo taxonomy.

In order to measure the Van Hiele Geometric Thinking level, it is recommended to solve a 25-question multiple-choice test called the "Van Hiele Geometry Comprehension Level" test. SOLO Taxonomy determines the level according to the nature of the answers given to the student after the questions asked.

Result and Suggestions

In our education life, we often use taxonomies in order to get to know the student or to reach the structure of their mathematical learning. In this study, the comparison of the Van Hiele geometric thinking model and SOLO Taxonomy, which are among the taxonomies we used, was examined. By using the Van Hiele Geometric Thinking Model, we can determine the level of geometric understanding of a learner whose level of geometric understanding we notice is lacking. In addition, by looking at the nature of the student's answer, we can determine its structure according to SOLO Taxonomy. These taxonomies are useful tools for teachers in education to evaluate student outcomes. If a decrease in learning levels is noticed after these tools are used, it is important to first find the reasons for this decrease. Taking measures for these reasons will make education more efficient.

References

Arı, A. (2013). Renewed Bloom, SOLO, Fink, Dettmer taxonomies in cognitive domain classification and their international recognition status. *Uşak University Journal of Social Sciences, 6(2), 259-290.*

Aydoğdu, M., Cevizci, A. B. and Tutak, T. (2022). Secondary School Students' Skills in Using Problem Solving Strategies Determining Teacher Opinions About. *Journal of Anatolian Education Research, 6(6), 1-14.*

Bagdat, O., & Saban, P. A. (2014). Examination of Algebraic Thinking Skills of 8th Grade Primary School Students with Solo Taxonomy. *The Journal of Academic Social Science Studies, 26(1), 473-496.*

Çakmak, D., & Gül, H. K. (2014). Determination of Geometric Thinking Levels of Primary Mathematics Teacher Candidates. *Turkish Journal of Educational Sciences, 12(1), 1-16.*

Çetinoğlu, B. (2013). *New Dimension in Learning: New Bloom Taxonomy*. enocta

Dogan, A. (2020). Examining the achievements in the primary school mathematics curriculum according to the SOLO classification. *Journal of Human and Social Sciences Research, 9(3), 2305-2325.*

Gökbulut, Y., Sidekli, S., & Yang, S. (2010). Examination of Classroom Teacher Candidates' Van Hiele Geometric Thinking Levels According to Some Variables (High School Type, High School Field, High School Average, ÖSS Scores, Undergraduate Averages and Gender). *Turkish Journal of Educational Sciences, 8(2), 375-396*.

Işık, A., Çiltaş, A., & Bekdemir, M. (2008). Necessity and Importance of Mathematics Education. *Atatürk University Kazım Karabekir Education Faculty Journal, (17), 174-184.*

Karahan, M. and Ergene, Ö. (2023). Analysis of Research in the Field of Mathematics Education in the Context of SOLO Taxonomy: A Meta-Synthesis Study. *Journal of Interdisciplinary Education: Theory and Practice, 5 (2), 107-122*

Ouellette, J. (2019). Physicists capture first footage of quantum knots unraveling in superfluid. Ars Technica.

Paksu, A. D. (2016). *Van Hiele levels of geometric thinking*. E. Bingölbali, S. Arslan, İÖ Zembat (Ed.).

Tutak, T., İlhan, A., İç, Ü. and Kılıçarslan, S. (2018). The Effects of Computer Aided Mathematics Teaching on Pre-service Mathematics Teachers' Views on Learning Processes. *Journal of Turkish Studies, 13(27), 1509-1524., Doi: 10.7827/TurkishStudies.14341*

Türnüklü, E., & Özcan, B. (2014). The Relationship Between Students' Knowledge Formation Processes According to RBC Theory in Geometry and Van Hiele Geometric Thinking Levels: Case Study. *Mustafa Kemal University Social Sciences Institute Journal, 11(27), 295-316.*

LITERATURE REVIEW ON REALISTIC MATHEMATICS EDUCATION, MATHEMATICAL MODELING AND VAN HIELE LEVELS OF GEOMETRIC THINKING

Sena Kaplan[1], Tayfun Tutak[2]

Abstract

The aim of this study is to discuss the similarities and differences between Realistic Mathematics Education (RME), Mathematical Modeling and Van Hiele Geometric Thinking Levels by using the literature, and to understand the effect of using these three approaches in mathematics education and to determine the relationships between them. For this purpose, a literature review was conducted and the document analysis method was used. While conducting the literature review, databases such as YÖKTEZ, Google Scholar, DergiPark and ERIC were used. In the research, 3 master's theses, 1 doctoral thesis, and 19 articles that were available regarding the subject of the study were examined and this study was created. Findings show that all three approaches are effective in teaching mathematics and deepen students' mathematical understanding. As a result, the similarities and differences of these theories were discussed in line with literature research, and it was seen that effective teaching can be provided in mathematics education with Realistic Mathematics Education (RME), Mathematical Modeling and Van Hiele Geometric Thinking Levels. Consideration and use of the suggested methods by teachers can help ensure more effective and permanent learning in mathematics education.

Key Words: Mathematics, Mathematics Education, Real Mathematics Education, Mathematical Modeling, Van Hiele Levels of Geometric Thinking

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Introduction

The primary school mathematics curriculum aims to raise individuals who can make sense of what they have learned in their environment and the school environment, create their own meanings, and apply the meanings they create to the situations they encounter in daily life. (Ministry of National Education [MEB], 2018; Canbazoğlu, Tarım, 2021). As stated here, mathematics has been seen as a difficult to understand, unsolvable and feared subject from past to present. The general reason for this situation is that an educational environment is not provided that can concretize situations where there are many abstract concepts. As a result of the studies, many methods emerged as ideas in mathematics education, such as giving examples from real-life situations, getting support from models to concretize them, and trying to handle them in a spiral manner from simple to difficult. In these ideas, many theories have been put forward in mathematics education by addressing both mathematics and non-mathematics subjects in real life situations, such as learning to learn, determining the level of existing knowledge and using models. The theories put forward provide guidance for more effective and permanent education and training. Three of these theories were discussed and the relationship between them was discussed. Theories examined; Realistic Mathematics Education (RME), Mathematical Modeling and Van Hiele Geometric Thinking levels.

Realistic Mathematics Education (RME); The foundations were laid by the Dutch mathematics educator Hans Freudenthal and by the Freudenthal Institute (FE); It is a mathematics teaching approach and an educational theory specific to the field of mathematics, developed in order to realize the innovation movement needed in mathematics teaching and learning (Treffers, 1987; De Lange, 1987; Streefland, 1990, Gravemeijer, 1994; Van den Heuvel-Panhuizen, 1996; Cansız, 2015). According to the RME approach, it is expressed as producing solutions to problems encountered in real life with information from our own lives and reaching mathematical information by creating new models or shapes (Tunalı, 2010). Freudenthal introduced learning mathematics as a process of meaning-making and expressed his opinion as "mathematics for the child begins with making sense, and in order to do real mathematics, making sense must be taken as the basis at every new stage" (Altun, 2006). GME focuses on reinterpreting mathematics with shapes and mathematizing it by generating solutions, analyzing and reasoning in real-life situations (Rezan, 2020).

Mathematization Hans Freudenthal and other researchers of the RME approach have called the formation of mathematical knowledge according to the RME approach "mathematization" (Freudenthal, 1968; Freudenthal, 1973; Freudenthal, 1979; Gravemeijer, 1997; Treffers, 1991; Van den Heuvel). -Panhuizen, 1996; Van den Heuvel-Panhuizen, 2001; Cansız, 2015).

Mathematization is divided into two, and according to Freudenthal, they are the same even though they both mention different features (Freudenthal, 1991).

Horizontal mathematization is the phase in which mathematical tools are suggested to solve a real-life problem, the environment for the solution is prepared and mathematical knowledge is produced from the model (Altun, 2001). In other words, horizontal mathematization; It is the phase of defining any real-life problem presented to students using mathematical expressions so that it can be solved mathematically (Gravemeijer & Doorman, 1999).

Vertical mathematization; It is the process of reaching higher level mathematics by working with symbols and reaching general or individual formulas by revealing the relationships between concepts (Altun, 2006). Representing a relationship within a formula, proving regularities, simplifying and correcting models, using different models, completing and combining models, formulating and generalizing a mathematical model are examples of vertical mathematization (Zulkardi, 2000).

Mathematical Modeling; It means developing a perspective on problems or issues other than mathematics encountered in real life with mathematical symbols and producing solutions (Tutak, İlhan, İç, and Kılıçarslan, 2018). The Effects of Computer Aided Mathematics Teaching on Pre-service Mathematics Teachers' Views on Learning Processes. Journal of Turkish Studies, 13(27), 1509-1524., Doi: 10.7827/TurkishStudies.14341

. Here, analysis and creativity are involved when generating solutions. In this sense, modeling is a multifaceted problem-solving process (Blum and Niss, 1991). However, according to Lingefjard (2002), mathematical modeling, beyond the meaning mentioned above, includes the processes of revealing relationships, performing mathematical analysis, obtaining results and reinterpreting the model. Mathematical modeling is a complex mathematical activity and includes teaching, learning and applications of modeling and many aspects of mathematical thinking and learning (Aydın, 2008). According to Niss (1998), mathematical modeling is the combination of one or more mathematical formations and the relationships between them, chosen to represent some of the real world situations and expectations. Galbraith and Catworthy (1990) defined mathematical modeling as the application of mathematics to unstructured problems in real life. Mathematical modelling; It is the process of trying to mathematically express an event, phenomenon, or relationships between events outside of mathematics and mathematics, and revealing mathematical patterns within these events and phenomena (Verschaffel, Greer, & De Corte, 2002).

Van Hiele Geometric Thinking Levels: Students are found in five hierarchical levels including visual, descriptive (analytical), simple inference (informal, deductive), inference and systematic thinking (Paksu, 2016). This inter-level progression develops with the student's learning processes and geometry experience, which differ from age and mental development (Paksu, 2016; Terzi, 2010). It expresses the features of existing objects such as shape appearances, names, features, similarities and differences according to their levels. He argued that it is impossible to achieve the desired learning when geometry teaching is done according to subjects at different levels than the students' level. These levels have language structure, symbols and relationships (Crowley, 1987; Usiskin, 1982; Van De Walle, 2004; Akt Çelik, Yılmaz, 2022). Van Hiele showed these levels as follows:

Level 1 (Visual Period): Perceives shapes as a whole and knows their names according to their appearance. At this level, students recognize geometric shapes from a holistic perspective. Students recognize and name shapes according to their general visual characteristics. They can evaluate shapes according to their similarities and sort groups of similar-looking shapes (Fuys et al., 1988).

Level 2 (Analytical Period): At this level, students analyze the parts of geometric shapes and the relationships between these parts. Students empirically discover the properties/rules of a shape class (e.g., by folding, measuring, using a grid or diagram) but cannot establish a hierarchical relationship between classes (Fuys et al., 1988). Knows and compares the properties of shapes.

Level 3 (Informal Deduction or Experiential Inference): At this level, students make connections between both properties of shapes (for example, in a quadrilateral, parallel sides require opposite angles to be equal) and classes of shapes (a square is a rectangle because it has all the properties of a rectangle). they can establish (Crowley, 1987). Relates, defines and orders the features of shapes and shapes.

Level 4 (Formal Deduction or Inference): At this level, students can prove themselves in an axiomatic system. Students can use axioms, postulates, definitions and theorems in proof studies related to geometry. He can determine necessary and sufficient conditions and use them to draw conclusions and prove them. They can also prove different theorems deductively by making use of theorems and proven axioms. For students who have reached this level, geometric shape features are a structure independent of objects and shapes (Hoffer, 1981; Akt Çelik, Yılmaz, 2022). They can understand axioms, create and demonstrate proofs, and reason.

Level 5 (Systematic Thinking): At this level, students identify relationships and differences between various axiomatic systems. Understands Euclidean and non-Euclidean geometry and can interpret the axioms, theorems and definitions of Euclidean geometry in non-Euclidean geometry and make applications related to these definitions (Hoffer, 1981). They can explain the effect of adding or removing an axiom to a particular geometric system (Vojkuvkova, 2012; Çelik, Yılmaz, 2022). Understands the differences between different axiomatic systems, relates them, creates theorems, analyzes and compares.

Purpose of the Study

The aim of this study is to conduct a literature study and examine the similarities and differences between Realistic Mathematics Education (RME), Mathematical Modeling and Van Hiele Levels of Geometric Thinking methods, and to understand the effect of using these three approaches in mathematics education, to determine the relationships between them and to contribute to mathematics education.

Method

Document analysis method was used. Document analysis includes the processes of finding, reading, taking notes and evaluating sources for a certain purpose (Karasar, 2005; Sak-Şahin, Öneren-Şendil. and Nas, 2021). A literature review has been conducted and there is a lot of research on these theories. From these studies, 3 master's theses, 1 doctoral thesis and 19 articles were examined and a literature review was created. Literature comes from the French word literature. According to TDK, it means literature and source. Literature, as we use it in the academic community, is a systematic collection of studies on a specific subject. Literature scanning is collecting data by examining existing sources and documents (URL).

Data collection tool

In the research, literature on Realistic Mathematics Education, Mathematical Modeling and Van Hiele geometric reduction levels was collected by scanning method from YÖK THESIS, DergiPark, GOOGLE AKADEMİK and ERIC databases. This process was carried out by following the necessary rules in accordance with the purpose of the research.

Data Collection Analysis

The data obtained in this research was examined with the document analysis method in accordance with its purpose. This method is also defined as examining written materials containing information about the phenomenon or phenomena that are targeted to be investigated (Yıldırım & Şimşek, 2013; Sak-Şahin, Öneren-Şendil. and Nas, 2021).

Findings

Differences and similarities between GME approach and Mathematical modeling

Mathematical modeling and RME approach both place more emphasis on real-life situations and argue that students develop their mathematical structures in the process of making sense of and mathematizing these real-life situations. Both approaches converge on the point that modeling is a tool in the process of teaching mathematics, that is, teaching mathematics using mathematical modeling. However, in the RME approach, modeling or the use of models is not the goal of education. On the contrary, it should be a tool for mathematization to be done in the easiest and best way possible. In both approaches, the common emphasis is on designing learning environments and materials using real-life problems. However, the ways mathematical modeling and the GME approach apply this differ. In mathematical modeling, the models used in lessons were prepared outside the students (Aydoğdu and Tutak, 2017). That is, students are expected to receive what has been embodied for them by others. The RME approach, on the other hand, rejects this and creates the models to be used based on real-life problems that are intended to be solved in the classroom environment, and is modified and improved when necessary. The models used in the RME approach are used not only to translate real-life problems into mathematical language, but also to organize actions and activities in a way that enables the formation and development of mental models in students (Cansız, 2015).

Differences and similarities between mathematical modeling and Van Hiele Levels of Geometric Thinking

Mathematical modeling is taking a subject outside of mathematics and expressing this subject mathematically in real life situations. Therefore, there is no similarity with Van Hiele's geometric thinking levels.

Differences and similarities between Van Hiele Levels of Geometric Thinking and GME

Van Hiele Geometric Thinking Levels have similarities with GME in the vertical mathematization part. Vertical mathematization is the process of reaching higher level mathematics, working with symbols and reaching general or individual formulas to reveal the relationships between concepts (Altun 2006). It corresponds to the 4th and 5th Levels of Van Hiele Geometric Thinking levels with features such as showing the relationship within a formula again, proving it, simplifying and correcting the models, using different models, and formulating (Zulkardi, 2000).

Learning in GME with Van Hiele Geometric Thinking Levels, students reach formal knowledge as a result of creating their own solutions and producing new models when comparing contextual situations selected from real life, based on informal knowledge existing in their own life experiences. Their difference is that in Van Hiele Geometric Thinking levels, the levels progress in a certain order, but this is not the case in GME. While Van Hiele is interested in the visible and given properties of the shape that exists in the first 3 steps, RME aims to ensure that students learn the information they obtain and produce, not the information that is ready for students in mathematics.

Result and Suggestions

The aim of this study is to examine the theories of Realistic Mathematics Education, Mathematical Modeling and Van Hiele Levels of Geometric Thinking and to examine the similarities and differences between them in order to make mathematics education more effective and permanent. Findings obtained using literature review and document analysis methods have shown that these three approaches are effective in mathematics education and increase students' mathematical learning and ensure their retention. When theories are considered, it has been seen that they are a tool during mathematics education and teaching. It has been seen that Realistic Mathematics Education and Mathematical Modeling address real life situations. However, it has been shown that Mathematical Modeling differs from RME by taking real-life examples from examples outside the field of mathematics. In addition to these two theories, the 4th and 5th Levels of Van Hiele's Geometric Thinking Levels came together in the vertical mathematization section of GME and were seen to have similarities. The similarity of these three theories is to enable students to learn mathematics in a more effective and concrete way.

As a result, using a combination of approaches such as RME, Mathematical Modeling and Van Hiele Levels of Geometric Thinking in mathematics education can strengthen students' mathematical thinking skills and deepen their relationships with mathematics. Taking these approaches into consideration by teachers can provide a more effective and impressive mathematics education experience.

1. Implementing the suggested approaches by teachers and using real-life problems can help students make mathematics more meaningful and permanent in their daily lives.
2. Approaches such as Mathematical Modeling and Van Hiele Levels of Geometric Thinking can improve students' analytical thinking skills and problem-solving abilities.

3. The use of Realistic Mathematics Education (RME) approach in mathematics education can improve students' in-depth understanding and strengthen their relationship with mathematics.
4. Adopting the Van Hiele Levels of Geometric Thinking approach in mathematics education can deepen students' understanding of geometry and help them understand abstract geometric concepts.
5. Mathematical modeling methods can be actively used in mathematics lessons to improve students' analytical thinking skills and increase their problem-solving abilities.

References

Aydoğdu, M. and Tutak, T. (2017). Developing Mathematical Modeling Activities for Secondary School 8th Graders. *The Journal of Academic Social Science (54), 155-166.*

Canbazoğlu, H. B., & Tarım, K. (2021). A teaching framework for mathematical modeling in primary school. *Dokuz Eylül University Buca Faculty of Education Journal, (51), 210-225.*

Cansiz, Ş. (2015). The effect of realistic mathematics education approach on students' mathematics achievement and creative thinking skills.

Celik, H. S., & Yilmaz, G. K. (2022). Analysis of Van Hiele Geometric Thinking Levels Studies in Turkey: A Meta-Synthesis Study. *International Journal of Curriculum and Instruction, 14(1), 473-501.*

Çilingir, E., & Artut, P. (2015). *The effect of realistic mathematics education approach on primary school students' visual mathematics literacy level and problem solving skills*. Çukurova University Social Sciences Institute, Adana.

Günhan, B. C., Doluzengin, B., Aksoy, B. D., & Özdişçi, S. (2022). The relationship between van hiele geometric thinking levels, achievement and attitude: a meta-analysis study. *Bayburt Faculty of Education Journal, 17(33), 274-293.*

Kandaga, T., Rosjanuardi, R., & Juandi, D. (2022). Epistemological Obstacle in Transformation Geometry Based on van Hiele's Level. *Eurasia Journal of Mathematics, Science and Technology Education, 18(4).*

Paksu, A. D. (2016). *Van Hiele levels of geometric thinking*. E. Bingölbali, S. Arslan, İÖ Zembat (Ed.).

Sak, R., Şahin Sak, İ. T., Öneren Şendil, Ç., & Nas, E. (2021). Document analysis as a research method. *Kocaeli University Education Journal, 4 (1), 227-256.*

Sert-Çelik, H. and Yılmaz, GK (2022). Analysis of Van Hiele geometric thinking levels studies in Turkey: A Meta-synthesis study: Van Hiele geometric thinking levels. International *Journal of Curriculum and Instruction, 14 (1), 473-501.*

Terzi, M. (2010). The effect of teaching situations designed according to Van Hiele geometric thinking levels on students' geometric achievement and geometric thinking skills.

Tutak, T., & Güder, Y. (2014). Definition, scope and importance of mathematical modeling. *Turkish Journal of Educational Studies, 1(1).*

Tutak, T., İlhan, A., İç, Ü. and Kılıçarslan, S. (2018). The Effects of Computer Aided Mathematics Teaching on Pre-service Mathematics Teachers' Views on Learning Processes. *Journal of Turkish Studies, 13(27), 1509-1524., Doi: 10.7827/TurkishStudies.14341*

Uça, S., & Saracoğlu, A. S. (2017). The use of realistic mathematics education in students' understanding of decimal fractions: A design study. *Elementary Education Online, 16(2), 469-496.*

URL https://www.akademikkaynak.com/literatur-nedir.html (cited May 7, 2024)

Yilmaz, R. (2020). Prospective Mathematics Teachers' Cognitive Competencies on Realistic Mathematics Education. *Journal on Mathematics Education, 11(1), 17-44.*

EXAMINATION OF SOME MISCONCEPTIONS OF 5TH AND 6TH GRADE STUDENTS ABOUT FRACTIONS AND THEIR REASONS

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Abstract

In this research, 5th and 6th grade students' misconceptions about fractions and their reasons were examined. Although the subject of fractions has an important place in mathematics, it is also a mathematical subject that we encounter in daily life and where it is difficult to correct misinformation when it is learned incorrectly. In this research, a literature study of the misconceptions and their causes on the subject of fractions was conducted, the causes of the misconceptions were tried to be determined, and suggestions were given to eliminate the misconceptions. As a result of the research, it was seen that students had many misconceptions and learning difficulties regarding the subject of fractions. It has been determined that the majority of students have difficulties with the concept of fractions and subjects related to the concept of fractions. The reason for these difficulties was the misconceptions they created and the learning difficulties they experienced while learning the concepts. Since the topics in the mathematics course are cumulative, the problems that occurred in the previous subjects continued in fractions. Articles that suggested solutions to these problems were examined and appropriate solution suggestions were added to the research. In this context, a descriptive and detailed research was conducted based on the information in the literature research.

Key Words: Mathematics, Fractions, Concept, Misconception

Introduction

A significant part of the studies carried out in the field of education and training is related to identifying students' misconceptions and lack of knowledge and looking for ways to eliminate them. Previous information

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and concepts form a stepping stone for the next ones. This also applies to mathematics education and learning. Solutions should be sought to provide students with complete knowledge of mathematics concepts, to identify misconceptions and lack of knowledge, and to eliminate these misconceptions and deficiencies (Küçük and Demir, 2009).

According to Dursun and Dede (2004), the factors that can positively or negatively affect an individual's mathematics success are as follows: the individual's age, development level, interests and needs, intelligence level, health, environment, teacher factor, school starting age, quality of the teaching environment, student's study habits, teaching methods, attitudes towards mathematics lessons and misconceptions.

Misconceptions are behaviors that occur as a result of an individual's false beliefs and experiences. Naturally, as students learn new concepts, they build on their previous knowledge. The preliminary achievements they have sometimes cause mislearning in learning new concepts. The solution of a problem or the execution of a procedure may be in line with the student's logic and previous achievements, and they may not know that what they are doing has no mathematical validity and may learn incorrectly (Baki, 1998). Since each incorrect learning will affect the next learning, it is extremely important to determine the misconceptions related to that learning area, which will also affect subsequent learning (Barak, 2007).

In recent research in mathematics education; It has been stated that it is not possible to teach in a way that will prevent students from forming any misconceptions, and that students make some incorrect learning and that these will remain hidden unless teachers make an effort to reveal them. Therefore, misconceptions can be limited by using learning styles that discuss and reveal misconceptions (Moss & Case, 1999).

Purpose of the Research

The purpose of this study is to determine the existence of misconceptions regarding the subject of fractions and the causes of misconceptions regarding the subject of fractions through a literature study. It is aimed to identify some suggestions for eliminating misconceptions and to examine them in detail.

Research Method

In this study, the causes of misconceptions regarding fractions and solution suggestions to eliminate misconceptions were examined. The research used a literature review method with the aim of analyzing the existing academic literature in depth. In this process, it aims to analyze the resources available in both print and digital media and, in this context, enables the determination of important findings and suggestions in seeking answers to research questions.

Studying group

The sample of the research consisted of articles and theses written on misconceptions regarding the subject of fractions, obtained from the sources of the Council of Higher Education Thesis Center (YÖK THESIS) and the National Academic Network and Information Center (ULAKBİM). This research was selected from the determined topics and added to the research.

Data collection tool

In the research, information about misconceptions was collected from the literature, YÖK THESIS and ULAKBİM databases by a regular scanning method. This process was carried out meticulously according to the goal of the research.

Analysis of Data

Descriptive analysis method was chosen to analyze the data collected in this study. This method allows the data to be restructured in accordance with the research problems and evaluated from different perspectives (Şimşek and Yıldırım, 2003).

What is Mathematics?

What is mathematics?" It seems that it is not currently possible to give a single and clear answer to the question that mathematicians and other scientists can agree with. Because people's expectations from mathematics, their experiences, perspectives, and definitions of mathematics explain only one aspect of mathematics and remain far from the whole subject. For example, seeing mathematics as a tool: it means a branch of science that ensures and deals with the continuation of human life (Hardy, 1994).

Those who see mathematics as a goal define mathematics as a tool for thinking and reaching the truth. G. H. Hardy, one of the respected mathematicians of the age, considered mathematics as a tool unimportant; He defines mathematics, which is seen as a goal, as true mathematics (Hardy, 1994).

What is the Concept?

In short, Ormrod (2003) calls the concept, which is the mental design of an object, phenomenon, situation and events, a group or categorization of similar events and objects in cognitive psychology. According to the Turkish Language Association dictionary, a concept is an abstract and general idea that includes the abstract and general design of an object or idea in the mind, the common features of objects and events, and collects them under a common name (TDK, 2005).

What is a Misconception?

Misconceptions; Misunderstandings are misinterpretations based on misunderstanding and interpretation. It is important to understand how misconceptions occur on the basis of school mathematics (Ojose, 2015). The term misconception, commonly expressed as misconception in English, is generally used in the literature as a perception or understanding that is far from the opinion that experts agree on a subject (Zembat, 2010).

It is very important to detect and prevent the mistakes students make while learning mathematical concepts. Since mathematics is a cumulative discipline, each concept learned affects the learning of the next concept (Aydoğdu and Tutak, 2017; Tutak, et al., 2018). Difficulty or incorrect learning in learning any concept may lead to misperceptions and difficulties in many subsequent concepts (Zembat, 2010).

Some Misconceptions About Fractions

An example of a misconception is given in Figure 1 below.

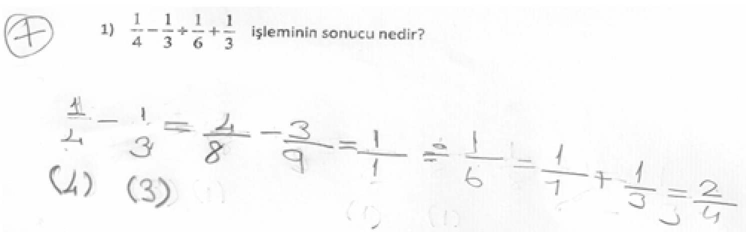


Figure 1. Misconception example 1 (Küçük and Demir, 2009)

As seen in Figure 1 above, the student has a misconception about operations with fractions. In this mistake, the student thought that the denominator and the number were added when equalizing the denominator in fractions. While he correctly performed the expansion of the resulting fraction in the solving phase of the problem, he continued to make mistakes in other operations. In addition, the student produced an incorrect solution to the question because he had a misconception about the priority of operations over fraction operations and thought that the numerators and denominators would be added separately when adding fractions.

An example of a misconception is given in Figure 2 below.

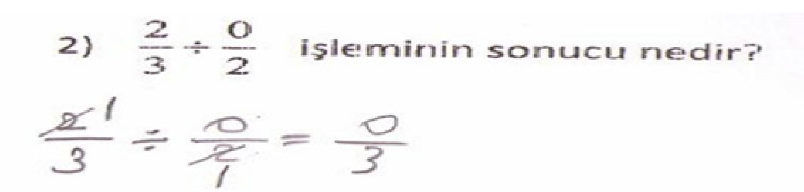


Figure 2. Misconception example 2 (Küçük and Demir, 2009)

In the question in Figure 2, the student has a misconception about dividing fractions. Although the student does not understand that the first fraction should be reversed and multiplied while dividing, he does not think that the fraction 0/2 is equal to 0, he knows that simplification is made in multiplication and thinks that he can also simplify division. For these reasons, the student produced a wrong solution. An example of a misconception is given in Figure 3 below.

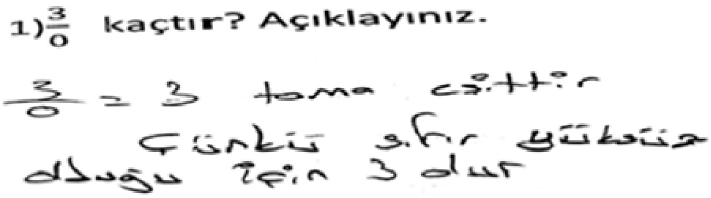


Figure 3. An example of a misconception (Küçük and Demir, 2009)

When Figure 3 above is examined, it can be seen that the student made a misconception by thinking that the answer is three when dividing the number three by zero, taking zero, which is the ineffective element in the addition process, as a reference. An example of a misconception is given in Figure 4 below.

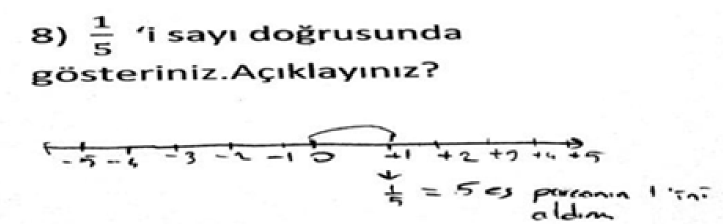


Figure 4. Misconception example 4 (Çakmak Gürel and Okur, 2016)

In Figure 4, the mistake made by the student is that he does not think that the fraction is between 0 and 1, but thinks that it is 1 of 5 equal parts. It is understood that the student's skills in performing basic operations with fractions and establishing equations are not fully developed. An example of a misconception is given in Figure 5 below.

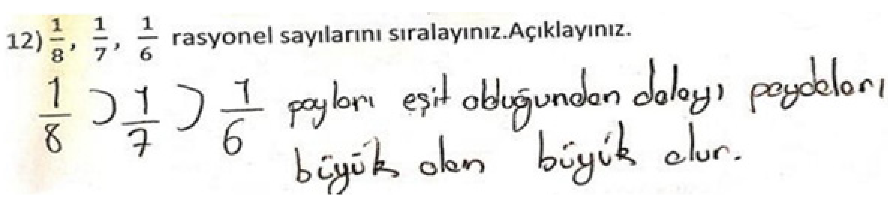


Figure 5. Misconception example 5 (Çakmak Gürel and Okur, 2016)

When Figure 5 above is examined, it is clearly seen that the student made a misconception by thinking only about the numerator and concluding that the result of fractions with larger denominators is greater, instead of equating the numerator or denominator and performing the operation. An example of a misconception is given in Figure 6 below.

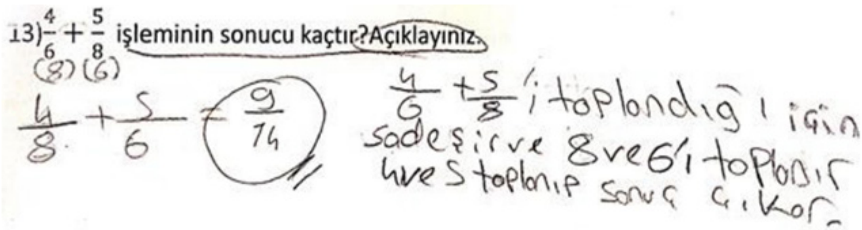


Figure 6. Misconception example 6 (Çakmak Gürel and Okur, 2016)

In Figure 6, the student's mistake is that although he knows that he needs to equate the denominator, he only writes the numbers to be equated in the denominator when equating, and when adding fractions, he adds the numerators and denominators separately to get the result.

An example of a misconception and the reasons for this example are given in Figure 7 below.

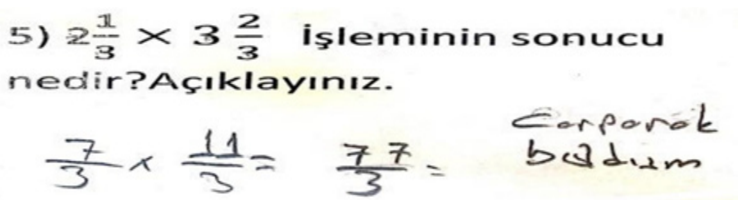


Figure 7. An example of a misconception and the reasons (Çakmak Gürel and Okur, 2016)

In this example, the student knows the transition from whole number fractions to compound fractions. However, the student's mistake is to multiply the numerators and write the denominator exactly when multiplying fractions.

An example of a misconception and the reasons for this example are given below in Figure 8.

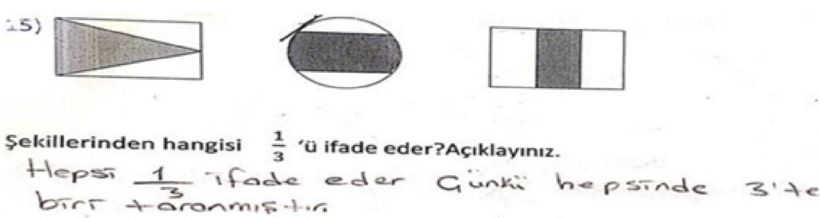
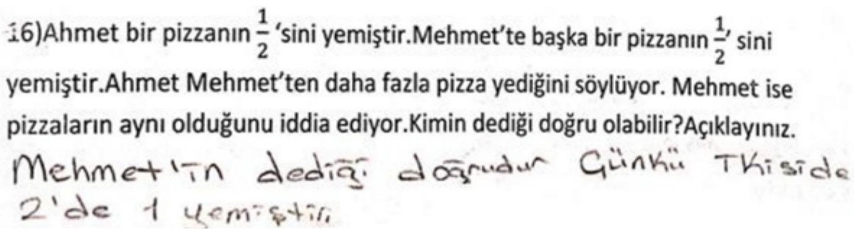


Figure 8. Misconception example 8 (Çakmak Gürel and Okur, 2016)

The student's mistake is to think that fractional expressions can be equal without taking into account the referenced magnitude. An example of a misconception and the reasons for this example are given below in Figure 9.

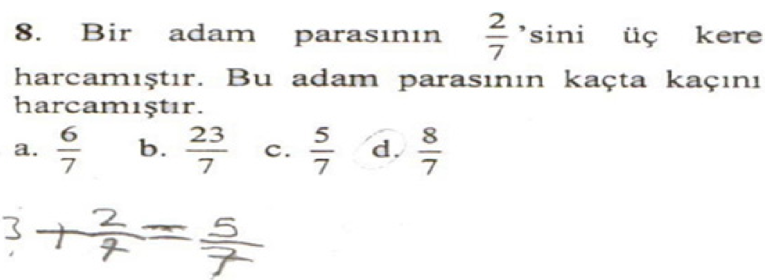

16)Ahmet bir pizzanın $\frac{1}{2}$ 'sini yemiştir.Mehmet'te başka bir pizzanın $\frac{1}{2}$' sini yemiştir.Ahmet Mehmet'ten daha fazla pizza yediğini söylüyor. Mehmet ise pizzaların aynı olduğunu iddia ediyor.Kimin dediği doğru olabilir?Açıklayınız.

Mehmet'in dediği doğrudur Çünkü ikiside 2'de 1 yemiştir

Figure 9. Misconception example 9 (Çakmak Gürel and Okur, 2016)

This student's mistake is that he answers the question without taking into account the reference size. Not commenting on the size of the pizza misled the student.

An example of a misconception and the reasons for this example are given below in Figure 10:


8. Bir adam parasının $\frac{2}{7}$'sini üç kere harcamıştır. Bu adam parasının kaçta kaçını harcamıştır.

a. $\frac{6}{7}$ b. $\frac{23}{7}$ c. $\frac{5}{7}$ d. $\frac{8}{7}$

$3 + \frac{2}{7} = \frac{5}{7}$

Figure 10. Misconception example 10 (Soylu, 2005)

This student's mistake is that she thinks of multiplication of fractions as addition and performs operations according to the numerator without thinking about the denominators when adding.

Result

This study focused on misconceptions in fractions and discussed in detail the misconceptions encountered by students and the reasons for these misconceptions. The findings show that misconceptions about fractions can be very diverse. Failure to acquire the conceptual foundations of process knowledge and establish the relationship between process knowledge and concepts results in failure to establish models and failure to decide where the processes will be used. For a student who learns operations as rules and cannot establish the connection between concepts, the relevant concepts may not have been formed, or although these concepts have been formed, the connection between operations and concepts may not be established, or several of these may not be realized at once (Baykul, 2005).

We can say that it would be more beneficial for teachers to take these learning difficulties of students into account when teaching fraction ordering. Using at least one example to show that ordering fractions with this logic is wrong and using techniques such as brainstorming to avoid misconceptions can encourage active learning.

One of the mistakes is adapting the rule of addition of fractions to multiplication of fractions. While explaining multiplication of fractions, teachers should show with concrete or daily life examples that the rules of addition and multiplication are not the same. Comparing the rule of multiplication to the rule of addition causes misconceptions in students over time (Soylu, 2005). Examples and activities that will not because misconceptions can put an end to students' misconceptions, so that students have the opportunity to learn permanent and accurate information.

Suggestions

- Many concrete and interesting materials on the subject of fractions should be prepared. In this way, it becomes easier for students to make sense of the subject and permanent learning is achieved.
- The teacher should ensure the active participation of students in the lesson with various discussion techniques. It should provide an environment where students can discuss the subject.
- In order to eliminate misconceptions about the subject during the lesson, students should be given examples that contradict their misconceptions and help them reach the correct conclusion.
- Teaching concepts should relate them to daily life and give examples from the environment.
- The teacher should be a guide in the lesson. It should support students in answering the questions, should not directly tell the wrong result, and should provide students with the opportunity to reach the correct conclusion (Küçük and Demir, 2009).

References

Aydoğdu, M. and Tutak, T. (2017). Developing Mathematical Modeling Activities for Secondary School 8th Graders. *The Journal of Academic Social Science (54), 155-166.*

Baki, A. (1998). Evaluation of Algebra-Related Misconceptions, *III. National Science Education Symposium, Trabzon.*

Barak, B. (2007). *Determining Misconceptions About Limits*, Master's Thesis, Balıkesir University, Institute of Science and Technology, Balıkesir.

Baykul, Y. (2005). *Teaching Mathematics in Primary Education (Grades 1-5).* Ankara: Pegem Publishing.

Çakmak-Gürel, Z. and Okur, M. (2016). Misconceptions of Secondary School 6th and 7th Grade Students about Fractions. *Erzincan University Faculty of Education Journal, 18(2), 922-952.*

Dursun, S. and Dede, Y. (2004). Factors Affecting Students' Success in Mathematics: In Terms of Mathematics Teachers' Opinions, *Gazi University Faculty of Education Journal, 24(2), 217 –230.*

Hardy, G. H. (1994). *"A Mathematician's Defense"* 4th Edition. (Translated by: Nermin Arık), TÜBİTAK Publications, Ankara.

Küçük, A. and Demir, B. (2009). Primary education 6–8. A Study on Some Misconceptions Encountered in Teaching Mathematics in Classrooms. *Dicle University Ziya Gökalp Faculty of Education Journal, 13, 97-112.*

Moss, J., and Case, R. (1999). Developing Children's Understanding of the Rational Numbers: A New Model and Experimental Curriculum. University of Toronto, 119-147. Canada

Ojose, B. (2015). Students' misconceptions in mathematics: analysis of remedies and what research says. Ohio Journal of School Mathematics, Fall 2015, Vol. 72.

Soylu, Y. and Soylu, C. (2005). Learning Difficulties of Primary School Fifth Grade Students on Fractions: Sorting, Addition, Subtraction, Multiplication and Problems Related to Fractions. *Erzincan Education Faculty Journal, 7(2), 101-107.*

Şiap, İ. and Duru, A. (2004). Ability to Use Geometric Models in Fractions. Gazi University *Kastamonu Education Journal 12, 1, 89-96.*

Şimşek, H. and Yıldırım, A. (2003). *Qualitative research methods in the social sciences*. Ankara: Seçkin Publishing.

Tutak, T., İlhan, A., İç, Ü. and Kılıçarslan, S. (2018). The Effects of Computer Aided Mathematics Teaching on Pre-service Mathematics Teachers' Views on Learning Processes. *Journal of Turkish Studies, 13(27), 1509-1524., Doi: 10.7827/TurkishStudies.14341*

Turkish Language Association (2005), Turkish Dictionary, https://www.tdk.org.tr/tdksozluk

Zembat, İ, Ö. (2010). *What is a misconception*? M. F. Özmantar, E. Bingölbali and H. Akkoç (Editors), Mathematical Misconceptions and Solution Suggestions. Ankara; Pegem Publishing.