Buca Eğitim Fakültesi Dergisi, 2023, sayı 57 , ss. 1906-1929

The Journal of Buca Faculty of Education, 2023, issue 57, pp. 1906-1929

Araştırma Makalesi

Research Article

Investigation of Mathematics Pre-service Teachers' Attitudes Towards Digital Technology in Terms of Demographic Variables

Matematik Öğretmen Adaylarının Dijital Teknolojiye Yönelik Tutumlarının Bazı Değişkenler Açısından İncelenmesi

Ahsen Filiz [1], Hasibe Sevgi Moralı[2]

[1]Sorumlu Yazar, Dr. Öğr. Üyesi, Biruni Üniversitesi, afiliz@biruni.edu.tr, (https://orcid.org/0000-0002-8886-5572)
[2]Dr. Öğr. Üyesi, Dokuz Eylül Üniversitesi, sevgi.morali@deu.edu.tr, (https://orcid.org/0000-0001-5603-9009)

Geliş Tarihi: *22.05.2023* ***Kabul Tarihi:*** *22.08.2023*

ABSTRACT

The role of technology continually increasing and its use is becoming no longer an option but inevitable in all fields of education. From teachers to students, technology literacy and the knowledge and skills to use it are now expected. Along with studies on the adequacy, skills, and approaches of students and educators from all levels regarding the use of technology, the attitudes of all these groups towards technology also fall under the scope of educational researchers. This study investigates whether the attitudes of pre-service mathematics teachers towards digital technology differ according to gender, university type, department, grade level and final grades in information technology courses, using statistical methods. The data set consists of the survey results of 440 mathematics pre-service teachers from two universities. According to the statistical results of the research, significant differences have been found in the attitudes of mathematics pre-service teachers towards digital technology in the sub-dimensions of technology use, conscious use of technology, and game-oriented use of technology, by gender; in the sub-dimensions of interest and willingness, technology use, and social media, by university type; and in the sub-dimensions of technology use and negative factors, based on the final grades of the information technology course. According to the data mining algorithms of the research, the branches generated by the Random Tree algorithm yielded the best results. According to the Random Tree algorithm, it was concluded that gender is the most dominant factor affecting the attitudes of mathematics pre-service teachers towards digital technology.

Keywords: Mathematics pre-service teachers, attitude towards digital technology, statistical methods.

ÖZ

Teknolojinin rolü sürekli artmakta ve kullanımı artık bir seçenek değil, eğitimin her alanında kaçınılmaz hale gelmektedir. Öğretmenlerden öğrencilere kadar artık teknoloji okuryazarlığı ve bunu kullanacak bilgi ve beceriler beklenmektedir. Her kademeden öğrenci ve eğitimcinin teknoloji kullanımına ilişkin yeterlilik, beceri ve yaklaşımları üzerine yapılan çalışmaların yanı sıra, tüm bu grupların teknolojiye yönelik tutumları da eğitim araştırmacılarının ilgi alanına girmektedir. Bu çalışmada, matematik öğretmeni adaylarının dijital teknolojiye yönelik tutumlarının cinsiyet, üniversite türü, bölüm, sınıf düzeyi ve bilişim teknolojileri dersindeki dönem sonu not ortalamalarına göre farklılık gösterip göstermediği istatistiksel yöntemler kullanılarak araştırılmıştır. Veri seti, iki üniversiteden 440 matematik öğretmen adayının anket sonuçlarından oluşmaktadır. Araştırmanın istatistiksel sonuçlarına göre, matematik öğretmen adaylarının dijital teknolojiye yönelik tutumlarında cinsiyete göre teknoloji kullanımı, teknolojinin bilinçli kullanımı

ve oyun amaçlı kullanımı alt boyutlarında; üniversite türüne göre ilgi ve isteklilik, teknoloji kullanımı ve sosyal medya alt boyutlarında; bilişim teknolojileri dersi dönem sonu not ortalamalarına göre ise teknoloji kullanımı ve olumsuz faktörler alt boyutlarında anlamlı farklılıklar bulunmuştur. Araştırmanın veri madenciliği algoritmalarına göre en iyi sonucu Random Tree algoritmasının oluşturduğu dallar vermiştir. Random Tree algoritmasına göre matematik öğretmen adaylarının dijital teknolojiye yönelik tutumlarını etkileyen en baskın faktörün cinsiyet olduğu sonucuna ulaşılmıştır.

Anahtar Kelimeler: Matematik öğretmen adayları, dijital teknolojiye yönelik tutum, istatistiksel yöntemler.

INTRODUCTION

It has been many years since the introduction of the word "technology" into our language, the word "technology" is frequently used by individuals of every generation and educational level in our daily lives and as its usage continues, its scope has constantly changed with scientific developments. Today, the role of technology continues to increase in all areas, no longer just an option but also becoming an inevitable part of the curriculum in education. In recent years, especially during the Covid pandemic period that unexpectedly hit the entire world, all groups related to education such as schools, teachers, students, and parents have had to meet and rapidly learn to use technology. From teachers to students, technology literacy and the knowledge and skills to use it are now expected. Along with studies on the adequacy, skills, and approaches of students and educators from all levels regarding the use of technology, the attitudes of all these groups towards technology also fall under the scope of educational researchers such as (Ganesh, 2021; Marzilli, 2014; Yavuz, 2008). Studies highlight the need for new tools and developments in the rich world of modern technology for the improvement and strengthening of education (Reychav, 2017). The inclusion of technology in education allows educators to create learning experiences that actively and meaningfully engage students with the course content (Borba, 2021).

The place and importance of technology in mathematics education have increased in recent years. First of all, technology is used to present new and interactive ways of teaching mathematical concepts, making it more interesting and understandable for students. It enables students to visualize mathematical concepts, explore mathematical ideas, conduct experiments with them, and access learning materials at their own pace using computer software, online resources, and educational applications. The use of technology increases a concrete and experimental approach to mathematical concepts and ensures success by addressing abstract and symbolic approaches to concrete concepts in later periods (Flores, 2002). Providing students with individual learning opportunities, it offers a learning environment suitable for their learning speeds (Akçay et al., 2007). Additionally, through computers, students develop a positive attitude towards math lessons by benefiting from educational games, simulations, problem-solving, and exercises. (Alakoç, 2003; Akçay et al., 2007).

Thus, technology can help students better understand concepts they have difficulty with and provide instant feedback and personalized learning experiences, which can be a preferred feature for both students and teachers. Zheng suggests that, learners will beneft more from technology-facilitated personalized learning than traditional learning (Zheng et al., 2022). Moreover, as technology provides easy and economical access to mathematical resources, it can help bridge the educational gap and enrich the education for all teachers and students, especially those with limited resources. Overall, technology has the potential to greatly enhance the learning experience and outcomes for both teachers and students.

In today's World, where the use of technology in mathematics education has become inevitable, the attitudes of teachers towards technology are important because teachers have the potential to shape students' perceptions of the role of technology in their lives and society. Teachers have a strong influence on students' attitudes towards mathematics (Ernest, 2004).

Attitudes towards technology can affect its adoption, use, impact, and potential. Positive attitudes towards technology can lead to more innovation and progress, while negative attitudes can hinder adoption and limit potential benefits. Therefore, it is important for teachers to have a positive attitude towards technology. Because the realization of effective education is directly related to the attitude towards the use of technology. Teachers who approach the use of technological tools and equipment positively in educational environments are expected to be more successful in the teaching process (Üstün & Akman, 2015).

Studies have shown that the assumption that students who have a positive attitude towards a particular topic will be more interested in that topic is correct (Krathwohl et al., 1964). It can be assumed that students who exhibit a positive attitude towards technology may have a higher likelihood of gaining technological literacy with the support of technology education, due to their higher interest in the subject (Bame et al., 1993). Therefore, more systematic research is needed to better understand the relationship between attitudes towards technology and technological literacy (Ardies et al., 2013).

Determining the attitudes of mathematics pre-service teachers, who will be the mathematics teachers of the near future, towards technology is important to enable studies aimed at identifying and resolving potential negative attitudes. Research suggests that various factors influence mathematics teachers' attitudes towards technology. For example, Marpa (2021) noted that male teachers have a more positive view of the use of technology in mathematics teaching compared to female teachers, and Barut's (2015) study found attitudes of male mathematics teachers was higher than females (Barut 2015; Marpa, 2021). According to Abbis (2018), studies conducted in the last thirty years show that gender is an unchanging factor in access to technology, technology usage, and attitude towards technology (Abbis, 2008). Another factor considered in research was whether candidates grade level has an effect on their attitude towards technology. While some research, such as Dargut and Çelik (2014), Yılmaz et al., (2014) and Şimşek (2015) found no significant difference, some studies, such as, Şahin and Arslan Namlı (2019), Aksoğan and Bulut Özbek (2020) found that attitudes became more positive as the grade levels increased. Knowing whether attitudes are positive or negative can ensure that necessary precautions are taken, especially during the education-teaching process (Cabı, 2016). The adoption of technology by future mathematics teachers helps to prepare students for the rapidly changing digital world and provides them with the necessary skills and knowledge to succeed in the 21st century. Therefore, it is important to conduct studies that can determine the attitudes of mathematics pre-service teachers towards technology, so that possible negative attitudes can be identified and resolved.

Studies examining attitudes towards technology generally aim to identify variables that may affect attitudes, such as gender and family socioeconomic status (Ardies, 2015; Davies & Brember, 2001). A limited number of studies have been found in the literature that attempt to identify variables that affect pre-service teachers' attitudes towards digital technology. Based on this, this study investigates whether the attitudes of mathematics pre-service teachers towards digital technology differ according to gender, department, grade level, university type, and final grades in information technology courses, using statistical methods. Thus, it is believed that this study will help fill a gap in the field. The following questions were addressed in the study."

1. The study examines whether there is a significant difference in the scores of math pre-service teachers on the digital technology attitude scale according to:

- Gender,
- Department,
- Grade level,
- University type,
- End-of-term grade point average in information technology courses using statistical methods.

2. Which variables are effective in determining the digital technology attitudes of mathematics pre-service teachers according to data mining algorithms?

Thus, it is believed that the study will help to fill the gap in the field.

METHOD

2.1 Research Design

In this study, a quantitative research method called the survey model was used to examine the differences in pre-service teachers' attitudes towards digital technology based on demographic variables. The survey model is used to collect data on the characteristics of a specific group of individuals (Büyüköztürk et al., 2011). The model of the study is given in Figure 1.

Fig. 1

Research Model

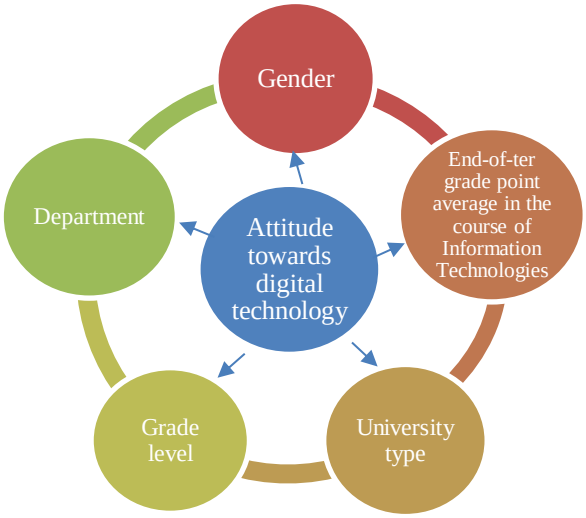


Figure 1 presents the conceptual framework of how the variables of gender, department, grade level, university type, and final grade point average of the information technologies course affect pre-service mathematics teachers' attitudes towards digital technology.

2.2 Research Group

The population of the study consists of the primary mathematics pre-service teachers at Biruni University in Istanbul, Turkey, and the secondary and primary mathematics pre-service teachers at Dokuz Eylül University in Izmir, Turkey. Students will be selected from the population using convenience sampling method. Convenience sampling is a method of sampling where the researchers work on the sample by including the most accessible respondents in the population until they reach the required sample size (Büyüköztürk et al., 2014).

2.3 Data Set

The data set of the study consists of the survey results of 440 mathematics pre-service teachers who participated in the study. The data was collected through data collection tools by the researchers. In the data set, the dependent variable to reveal the mathematics pre-service teachers' attitudes towards digital technology is their attitude towards digital technology, and the demographic variables are gender, department, grade level, university type, and end-of-term

average of the course on information technologies. The attitudes of mathematics pre-service teachers towards digital technology were categorized as low, medium, and high. The characteristics of the variables are given in the Table 1 below. The classification of the characteristics of the variables given in Table 1 is similarly given in the study of Göktepe Körpeoğlu and Göktepe Yıldız (2023).

Table 1

Independent Attributes

Independent attributes	Classification	Type
Gender	male, female	String type
Education Level	primary mathematics pre-service teachers, secondary mathematics pre-service teachers	String type
Score	AA, BA, BB, CB, CC, DC, DD	String type
Grade Level	The grade levels of the students (1th, 2th, 3th and 4th)	Real type
School Type	Public school, private school	String type

2.4 Ethics Statement

Prior to commencing the research, permission was obtained from the ethical committee of Biruni University under the number 2023/78-06, and it has been confirmed that there will be no ethical issues.

The authors declare no conflict of interest. The research is a study involving human participants. Therefore, data were collected after the participants approved the written informed consent form.

2.5 Data Collection Tools

2.5.1 Digital Technology Attitude Scale

Cabı (2016) designed a scale consisting of 39 items and eight subscales to determine the attitudes of high school students towards digital technology. The subscales include competence (10 items), social networks (4 items), technology use in class (4 items), interest (5 items), technology for me (9 items), entertainment use (4 items), and conscious use (3 items). The questionnaire is a 5-point Likert scale. Response options for items are 1 (strongly disagree), 2 (disagree), 3 (undecided), 4 (agree), and 5 (strongly agree). The Cronbach's α value for the entire scale was calculated as 0.90, and for each factor, it was calculated as 0.86, 0.85, 0.78, 0.69, 0.66, 0.66, 0.61, and 0.61, respectively.

2.6 Data Collection Process

The data collection process was carried out during the 2022-2023 academic year. Necessary permissions were obtained before collecting the data for the survey. Prior to answering the survey questions, the necessary explanations were provided to the pre-service teachers and voluntary participation was adopted for the research. The participating pre-service teachers were asked to answer each survey question and not to leave any questions blank. Because unanswered questions would result in a decrease in the number of data and lead to incorrect evaluation results.

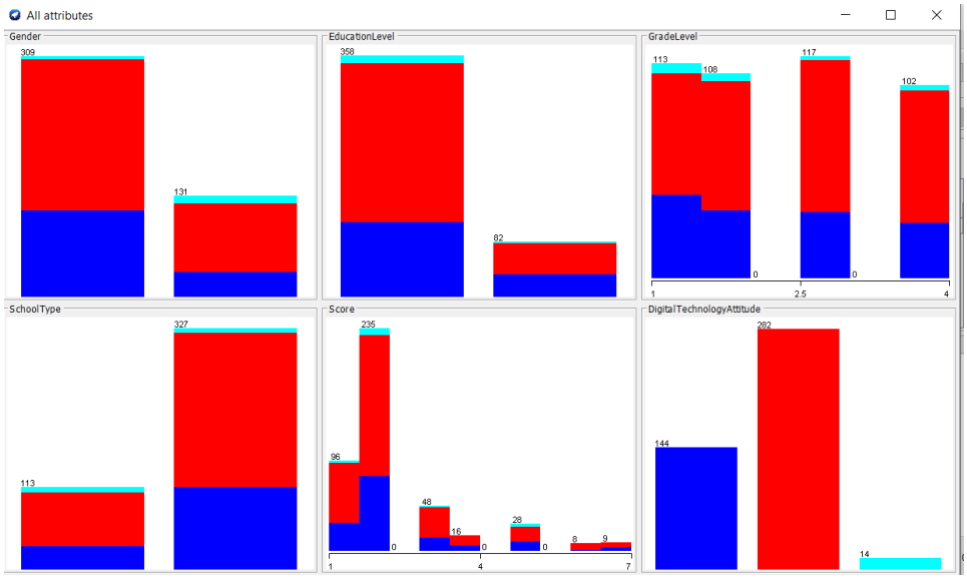
2.7 Data Analysis

SPSS 20 program was used for statistical analysis of the data. Within the scope of the study, frequency distribution, factor analysis, reliability test, and Kolmogorov-Smirnov normality test were conducted for the variables under investigation. Since the data did not show normal distribution, non-parametric tests such as Mann-Whitney U test and Kruskal-Wallis test were used to analyze the data.

The data mining software WEKA version 3.8.4 was used to determine which variables were effective in determining mathematics pre-service teachers' attitudes towards digital technology. WEKA is an open-source software developed by the University of Waikato in New Zealand that contains many classification techniques (Aydemir, 2017). The data obtained from the mathematics pre-service teachers' attitude towards digital technology scale in the study were transferred to an excel file and then opened with notepad to be converted to the arff file format for use with the WEKA program. The variables and types containing these data are given in Figure 2.

Fig. 2

Graphs with Variables



@attribute Gender { Female,Male }
@attribute
EducationLevel{primarymathematicspreserviceteachers,secondarymathematicspreserviceteache
rs }
@attribute GradeLevel real
@attribute SchoolType { PrivateSchool,PublicSchool }
@attribute Score { AA, BA, BB, CB, CC, DC, DD }
@attribute DigitalTechnologyAttitude { Low,Middle,High }
@data
Female,primarymathematicspreserviceteachers,4,PrivateSchool,4,Low
Male,primarymathematicspreserviceteachers,3,PrivateSchool,2,Middle
Male,primarymathematicspreserviceteachers,4,PrivateSchool,4,Middle
Female,primarymathematicspreserviceteachers,4,PrivateSchool,2,Middle
Female,primarymathematicspreserviceteachers,4,PrivateSchool,2,Low
Female,primarymathematicspreserviceteachers,4,PrivateSchool,2,Middle
Male,primarymathematicspreserviceteachers,4,PrivateSchool,1,Low
Male,primarymathematicspreserviceteachers,4,PrivateSchool,4,Middle
Female,primarymathematicspreserviceteachers,4,PrivateSchool,2,High
Male,primarymathematicspreserviceteachers,3,PrivateSchool,3,Middle
Male,primarymathematicspreserviceteachers,3,PrivateSchool,5,Middle
Male,primarymathematicspreserviceteachers,3,PrivateSchool,3,Middle
……

The attributes of the data obtained from the scale of pre-service mathematics teachers' attitudes towards digital technology and the nominal values that these attributes can take are given above.

RESULTS AND COMMENTS

In this section, firstly, frequency, percentage distribution, factor analysis and reliability test of the attitude towards digital technology scale data obtained from the study group are given. Then, the attitudes of pre-service mathematics teachers towards digital technology were interpreted under two main headings according to statistical methods and data mining algorithm.

3.1 Frequency Distributions of the Study Group According to Investigated Variables

In the study, the frequency and percentage distributions of the responses given by 440 pre-service teachers to the digital technology attitude survey questions related to the investigated variables (gender, department, grade level, university type, end-of-semester grades of information technologies course) are given in Table 2.

Table 2

Frequency and Percentage Distributions of Demographic Information of the Study Group

Variables	Groups	Frequency	Percentage
Gender	Male	131	30
	Female	309	70
	Sum	440	100
Department	primary mathematics pre-service teachers,	358	81
	secondary mathematics pre-service teachers	82	19
	Sum	440	100
Grade Level	1.grade	113	26
	2.grade	108	25
	3.grade	117	26
	4.grade	102	23
	Sum	440	100
University Type	Private School	113	26
	Public School	327	74
	Sum	440	100
End-of-term grade point average of Information Technologies course	AA	96	22
	BA	235	53
	BB	48	11
	CB	16	4
	CC	28	6
	DC	8	2
	DD	9	2
	Sum	440	

3.2 Factor Analysis and Reliability Test for Attitude Scale Towards Digital Technology

Factor analysis was performed to determine the variable groups of the attitude scale towards digital technology. Questions 4, 5, 22, and 32 were excluded from the analysis because they exhibited collinearity, i.e., they had similar values under different factor weights. The factor analysis, reliability test, and KMO and Barlett's test of the scale are provided in Table 3.

Table 3

Results of Factor Analysis and Reliability Test for Attitude Scale towards Digital Technology

	Questions	Factor Weights	Factor explainability (%)	Initial Eigenvalues	Cronbach's Alpha
Interest and willingness	T14	0.694			
	T15	0.675			
	T11	0.612			
	T6	0.570	10.057	7.044	0.79
	T8	0.547			
	T12	0.546			
	T28	0.512			
	T9	0.481			
Technology usage	T3	0.723			
	T1	0.719			
	T29	0.650	9.789	3.200	0.81
	T30	0.593			
	T7	0.570			
	T31	0.528			
Conscious use of technology	T37	0.707			
	T33	0.621			
	T35	0.619	9.138	2.607	0.76
	T38	0.602			
	T21	0.585			
	T36	0.579			
Social media	T17	0.828			
	T16	0.769			
	T18	0.756	8.269	1.872	0.74
	T19	0.583			
	T39	0.425			
	T10	0.424			
Awareness of the importance of technology	T2	0.716			
	T34	0.647	5.736	1.767	0.54
	T26	0.488			
Negative factors	T27	0.777			
	T20	0.703			
	T24	0.636	5.719	1.197	0.58
	T13	0.410			
Game oriented use	T25	0.701			
	T23	0.621	5.152	1.165	0.64
KMO Value: 0.854, Bartlett's Test Result: 0.000, Explained Sum Variance: 53.860					

In Table 3, the KMO test result for the scale was calculated as 0.854 and the p-value of Barlett's test was 0.000. Based on these values, it can be said that the data is suitable for factor analysis. According to the factor analysis and reliability test results of the attitude scale towards digital technology, a total of 7 factors were identified in the table that explains the total variance, and the variables were grouped under 7 factors. Accordingly, factor 1 was named "interest and willingness," factor 2 "technology usage," factor 3 "conscious use of technology," factor 4 "social media," factor 5 "awareness of the importance of technology," factor 6 "negative factors," and factor 7 "game-oriented use." The dimension of interest and willingness explains 10.057% of the total variance, the dimension of technology usage explains 9.789% of the total variance, the dimension of conscious use of technology explains 9.138% of the total variance, the dimension of social media explains 8.269% of the total variance, the dimension of knowing the importance of technology explains 5.736% of the total variance, the dimension of negative factors explains

5.719% of the total variance, and the dimension of game purpose usage explains 5.152% of the total variance. The seven factors explain a total variance of 53.860% (Table 3). The initial eigenvalues for factor 1 are found to be 7.044, for factor 2 are 3.200, for factor 3 are 2.607, for factor 4 are 1.872, for factor 5 are 1.767, for factor 6 are 1.197, and for factor 7 are 1.165. Cronbach's Alpha value is calculated as 0.79 for factor 1, 0.81 for factor 2, 0.76 for factor 3, 0.74 for factor 4, 0.54 for factor 5, 0.58 for factor 6, and 0.64 for factor 7.

A Kolmogorov-Smirnov normality test was conducted to determine whether the sub-dimensions of the digital technology attitude scale had a normal distribution or not (Table 4). Based on the results, it was determined whether parametric or non-parametric tests would be applied to the data.

Table 4

Results of the Kolmogorov-Smirnov Normality Test for Digital Technology Attitude Scale

	Mean	**Standard Deviation**	**Kolmogorov-Smirnov Z**	**Asymp. Sig. (2-tailed)**
Interest and willingness	3.848	.554	2.234	.000
Technology usage	3.425	.637	1.429	.034
Conscious use of technology	3.733	.546	2.041	.000
Social media	3.532	.700	1.618	.011
Awareness of the importance of technology	4.215	.519	3.479	.000
Negative factors	2.437	.652	2.537	.000
Game-oriented use	2.480	1.024	3.406	.000

As seen in Table 4, the sub-dimensions of the digital technology attitude scale are not normally distributed since $p<0.05$. Therefore, non-parametric tests such as Mann-Whitney U test have been applied for binary comparisons and Kruskal-Wallis tests have been applied for comparisons of more than two groups.

According to statistical methods, the attitudes of mathematics pre-service teachers towards digital technology were examined based on sub-problems.

3.3 The Results of Prospective Mathematics Teachers' Attitudes towards Digital Technology According to Statistical Methods.

3.3.1 Findings Related to the Significance of Differences by Gender in the Attitudes of Mathematics Pre-Service Teachers towards Digital Technology.

The differences in the sub-dimensions of pre-service teachers' attitudes towards digital technology by gender were analyzed using the Mann-Whitney U test (Table 5).

Table 5

Mann-Whitney U Test Results for Differences in Digital Technology Attitude Scale Sub-dimensions by Gender

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Interest and willingness	18048.000	65943.000	-1.803	.071
Technology usage	14693.000	62588.000	-4.564	.000
Conscious use of technology	15120.500	63015.500	-4.223	.000
Social media	18849.000	66744.000	-1.143	.253
Awareness of the importance of technology	18206.000	26852.000	-1.708	.088
Negative factors	19376.500	67271.500	-.714	.475
Game-oriented use	14071.500	61960.500	-5.126	.000

Table 5 shows that there are significant differences in the sub-dimensions of the digital technology attitude scale of pre-service teachers according to gender, as analyzed by the Mann-Whitney U test. Specifically, the sub-dimensions of technology use, conscious use of technology, and gaming purposes show differences based on gender ($p<0.05$).

The averages of the differences of the sub-dimensions of pre-service teachers' attitudes towards digital technology according to gender are given in Table 6.

Table 6

Means for Differences in Digital Technology Attitudes Subscales According to Gender

	Gender	N	Rank Averages
Interest and willingness	Female	309	213.41
	Male	131	237.23
	Sum	440	
Technology usage	Female	309	202.55
	Male	131	262.84
	Sum	440	
Conscious use of technology	Female	309	203.93
	Male	131	259.58
	Sum	440	
Social media	Female	309	216.00
	Male	131	231.11
	Sum	440	
Awareness of the importance of technology	Female	309	227.08
	Male	131	204.98
	Sum	440	
Negative factors	Female	309	217.71
	Male	131	227.09
	Sum	440	
Game oriented use	Female	309	200.54
	Male	131	267.58
	Sum	440	

According to Table 6, it can be observed that the rank averages of male pre-service teachers are higher than those of female pre-service teachers in terms of the sub-dimensions of technology use, conscious use of technology, and use of technology for gaming ($p<0.05$). The rank average of male pre-service teachers for technology use sub-dimension is 262.84 while it is 202.55 for female pre-service teachers. The rank average of male pre-service teachers for conscious use of technology sub-dimension is 259.58 while it is 203.93 for female pre-service teachers. The rank

average of male pre-service teachers for the use of technology for gaming sub-dimension is 267.58 while it is 200.54 for female pre-service teachers. Therefore, it can be said that male pre-service teachers are more active and interested in using technology compared to female pre-service teachers in terms of technology use, conscious use of technology, and use of technology for gaming.

3.3.2 The Findings Regarding the Significance of Pre-Service Teachers' Attitudes towards Digital Technology According to Department

The sub-dimensions of pre-service teachers' attitudes towards digital technology were analyzed according to the department by Mann-Whitney U test to determine whether they differ or not (Table 7).

Table 7

Mann-Whitney U Test Results for Differences in Sub-dimensions of Attitude Scale towards Digital Technology by Department

	Mann-Whitney U	**Wilcoxon W**	**Z**	**Asymp. Sig. (2-tailed)**
Interest and willingness	13769.500	17172.500	-.878	.380
Technology usage	13487.500	77748.500	-1.150	.250
Conscious use of technology	14200.000	78461.000	-.463	.643
Social media	13410.000	16813.300	-1.224	.221
Awareness of the importance of technology	14368.500	17771.500	-.305	.760
Negative factors	13348.500	16751.500	-1.291	.197
Game-oriented use	14537.500	78798.500	-.137	.891

Table 7 shows that there is no significant difference in the sub-dimensions of attitude scale towards digital technology among prospective teachers based on their departments of primary mathematics teaching and secondary mathematics teaching ($p>.05$).

3.3.3. Findings on the Significance of the Pre-Service Teachers' Attitudes towards Digital Technology by Grade Level.

The sub-dimensions of pre-service teachers' attitudes towards digital technology were analyzed by Kruskal Wallis test to determine if there were any differences based on grade level (Table 8).

Table 8

Kruskal Wallis Test Results for Differences in Sub-dimensions of Attitude Scale towards Digital Technology by Grade Level

	Chi-Square	**Df**	**Asymp. Sig.**
Interest and willingness	.675	3	.879
Technology usage	2.666	3	.446
Conscious use of technology	1.021	3	.796
Social media	3.742	3	.291
Awareness of the importance of technology	2.233	3	.526
Negative factors	2.081	3	.556
Game-oriented use	1.845	3	.605

Table 8 shows that there is no significant difference in the sub-dimensions of attitude scale towards digital technology among prospective teachers based on their grade level (p>.05).

3.3.4 Findings on the Significance of the Pre-Service Teachers' Attitudes towards Digital Technology by University Type

The sub-dimensions of pre-service teachers' attitudes towards digital technology were analyzed by Mann-Whitney U test to determine if there were any differences based on university type (Table 9).

Table 9

Mann-Whitney U Test Results for Differences in Sub-dimensions of Attitude Scale towards Digital Technology by University Type

	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Interest and willingness	15920.000	69548.000	-2.200	.028
Technology usage	15081.500	68709.500	-2.923	.003
Conscious use of technology	16998.500	70626.500	-1.275	.202
Social media	15457.500	69085.500	-2.597	.009
Awareness of the importance of technology	18373.000	24814.000	-.090	.928
Negative factors	16367.500	69995.500	-1.825	.068
Game-oriented use	16776.500	70404.500	-1.478	.139

Table 9 shows that there are significant differences in the sub-dimensions of pre-service teachers' attitudes towards digital technology, namely interest and willingness, technology use, and social media, based on university type (p<0.05).

The averages of the sub-dimensions of pre-service teachers' attitudes towards digital technology according to the type of university are given in Table 10.

Table 10

Means for Differences in Sub-dimensions of Attitude Scale towards Digital Technology by University Type

	University Type	N	Rank Averages
Interest and willingness	Private	113	243.12
	Public	327	212.69
	Sum	440	
Technology usage	Private	113	250.54
	Public	327	210.12
	Sum	440	
Conscious use of technology	Private	113	233.57
	Public	327	215.98
	Sum	440	
Social media	Private	113	247.21
	Public	327	211.27
	Sum	440	
Awareness of the importance of technology	Private	113	219.59
	Public	327	220.81
	Sum	440	
Negative factors	Private	113	239.15
	Public	327	214.05
	Sum	440	

Game oriented use	Private	113	235.54
	Public	327	215.30
	Sum	440	

Looking at Table 10, it can be seen that the average scores for the sub-dimensions of interest and willingness (243.12), technology use (250.54), and social media (247.21) of pre-service teachers studying at private universities are higher than the average scores of pre-service teachers studying at public universities for the same sub-dimensions of interest and willingness (212.69), technology use (210.12), and social media (211.27).

3.3.5 Findings Regarding the Significance of the Relationship Between Pre-Service Teachers' Attitudes towards Digital Technology and Their Final Grades in the Information Technology Course

The differences, if any, between the sub-dimensions of pre-service teachers' attitudes towards digital technology and their end-of-semester grade point averages in the computer technologies course were analyzed through the Kruskal Wallis test (Table 11).

Table 11

Kruskal Wallis Test Results on Differences in Digital Technology Attitude Scale Sub-Dimensions according to ICT Course End-of-Term Grade Averages

	Chi-Square	**Df**	**Asymp. Sig.**
Interest and willingness	1.844	6	.933
Technology usage	13.105	6	.041
Conscious use of technology	7.328	6	.292
Social media	4.690	6	.584
Awareness of the importance of technology	9.811	6	.133
Negative factors	15.906	6	.014
Game-oriented use	3.310	6	.769

Table 11 shows that there is a significant difference in the sub-dimensions of the digital technology attitudes scale, namely "Technology usage" and "Negative factors", based on the end-of-term average grades of the pre-service teachers in the computer technologies course ($p<0.05$).

Table 12 shows the final grade point averages of the sub-dimensions of pre-service teachers' attitudes towards digital technology in the information technologies course.

Table 12

Means for Differences in Digital Technology Attitude Scale Sub-Dimensions by End-of-Term Averages for Information Technology Courses

	Averages	**N**	**Rank Averages**
Interest and willingness	AA	96	223.55
	BA	235	218.04
	BB	48	233.49
	CB	16	190.78
	CC	28	230.57
	DC	8	220.13
	DD	9	204.72
	Sum	440	
Technology usage	AA	96	232.28
	BA	235	210.00
	BB	48	234.85

	CB	16	207.03
	CC	28	253.39
	DC	8	309.06
	DD	9	135.28
	Sum	440	
Conscious use of technology	AA	96	216.44
	BA	235	219.65
	BB	48	226.11
	CB	16	180.34
	CC	28	260.45
	DC	8	263.94
	DD	9	164.50
	Sum	440	
Social media	AA	96	217.17
	BA	235	214.70
	BB	48	242.75
	CB	16	215.97
	CC	28	256.46
	DC	8	204.44
	DD	9	199.28
	Sum	440	
Awareness of the importance of technology	AA	96	247.63
	BA	235	215.12
	BB	48	223.01
	CB	16	186.47
	CC	28	217.71
	DC	8	141.44
	DD	9	197.61
	Sum	440	
Negative factors	AA	96	184.11
	BA	235	226.25
	BB	48	217.52
	CB	16	288.28
	CC	28	250.32
	DC	8	214.94
	DD	9	266.11
	Sum	440	
Game oriented use	AA	96	215.31
	BA	235	215.10
	BB	48	243.68
	CB	16	232.19
	CC	28	231.73
	DC	8	254.94
	DD	9	206.94
	Sum	440	

According to Table 12, the rank order of the Technology usage sub-dimension score (309.06) of the pre-service teachers who had a final grade of DC in the information technologies course is higher than the rank order of other letter grades.

The rank order of the negative factors sub-dimension score (288.28) of the pre-service teachers who had a final grade of CB in the information technologies course is higher than the rank order of other letter grades.

3.4 According to Data Mining Algorithms, Resultings the Attitudes of Mathematics Pre-Service Teachers towards Digital Technology

According to the WEKA program, many decision tree algorithms are used for model building. The grading algorithms, performance measurements, and success rates of the data used in this study are given in Table 13 below.

Table 13

Grading Algorithms, Performance Measurements, and Achievement Levels

Algorithms	Correctly classified number of instances	Accuracy	TP Rate	FP Rate	Precision	Recall	F-Measure
K-Star	290	65,9091	0,982	0,911	0,658	0,982	0,788
J4.8	283	64,3182	0,993	0,981	0,644	0,993	0,781
SMO	282	64,0909	1,000	1,000	0,641	1,000	0,781
PART	279	63,4091	0,954	0,924	0,648	0,954	0,772
Logistic Regression	279	63,4091	0,972	0,968	0,642	0,972	0,773
Naive Bayes	277	62,9545	0,968	0,975	0,639	0,968	0,770
Multilayer Perceptron	271	61,5909	0,908	0,905	0,642	0,908	0,752
Random Forest	265	60,2273	0,872	0,867	0,642	0,872	0,740
Random Tree	260	59,0909	0,826	0,823	0,642	0,826	0,722
IBk	260	59,0909	0,833	0,816	0,646	0,833	0,728
Random Committe	257	58,4091	0,826	0,823	0,642	0,826	0,722

The results obtained from the WEKA program are shown in Table 13. Different algorithms are used for the model creation in WEKA program. Therefore, in this study, the algorithms with high success rates were preferred. According to the correct classification percentages of the algorithms, the most successful algorithm in terms of accuracy rate is the K-Star algorithm with 65.9091% accuracy rate. When all criterion values are examined, the algorithm with the lowest correct classification percentage is the Random Committe algorithm with a 58.4091% accuracy rate.

3.4.1 Confusion matrix of Random Tree algorithm

Based on the obtained data, the most successful algorithm within the tree category was determined as Random Tree, and the confusion matrix and the grades produced by the model are given below.

Table 14

Confusion Matrix

	Predicted Class			
		Low	Middle	High
Actual Class	Low	25	119	0
	Middle	45	235	2
	High	5	9	0

Table 14 shows the confusion matrix of the Random Tree algorithm used to grade the digital technology attitudes of math pre-service teachers. According to the Random Tree algorithm grading, 235 pre-service mathematics teachers with moderate level of digital technology attitudes were correctly graded.

Fig. 3

Random Tree Decision Tree Branches

```
Gender = Female
|   Score < 1.5
|   |   GradeLevel < 3.5
|   |   |   GradeLevel < 2.5
|   |   |   |   EducationLevel = elementarymathematicspreserviceteachers : Middle (21/8)
|   |   |   |   EducationLevel = secondarymathematicspreserviceteachers : Middle (5/2)
|   |   |   GradeLevel >= 2.5
|   |   |   |   SchoolType = PrivateSchool : Middle (1/0)
|   |   |   |   SchoolType = PublicSchool
|   |   |   |   |   EducationLevel = elementarymathematicspreserviceteachers : Middle (22/10)
|   |   |   |   |   EducationLevel = secondarymathematicspreserviceteachers : Low (4/2)
|   |   GradeLevel >= 3.5
|   |   |   EducationLevel = elementarymathematicspreserviceteachers : Middle (10/2)
|   |   |   EducationLevel = secondarymathematicspreserviceteachers : Middle (5/2)
```

The various branches of the decision tree are shown in the Figure 3. As a result of grading digital technology attitudes as low, medium, and high, the branches generated by the Random Tree algorithm are as follows:

Gender: Female, Final grade for computer technologies course: below AA, Grade: less than 2, Department: Primary School Mathematics Teaching, intermediate level of digital technology (21 mathematics pre-service teachers)

Gender: Female, End-of-term grade in Information Technologies course: below AA, Grade: less than 2, Department: Secondary Mathematics Education, moderate level of digital technology proficiency (5 mathematics pre-service teachers)

Gender: Female, End-of-term average grade in Computer Technologies course: lower than AA, Grade: higher than 2, Department: Primary School Mathematics Teaching, School Type: Public, intermediate level of digital technology (22 mathematics pre-service teachers)

Gender: Female, End of term grade for Information Technologies course: below AA, Grade: greater than 2, Department: Secondary Mathematics Teaching, School type: Public, High level of digital technology proficiency (4 mathematics pre-service teachers)

Gender: Female, End-of-term grade for Information Technologies course: below AA, Grade: greater than 3, Department: Primary School Mathematics Teaching, Medium level of digital technology proficiency (10 mathematics pre-service teachers)

Gender: Female, End-of-semester grade for Information Technologies course: lower than AA, Grade: greater than 3, Department: Secondary School Mathematics Teaching, intermediate level of digital technology (5 mathematics pre-service teachers)

The Random Tree decision tree for digital technology attitude grading is given in Figure 4 below.

Fig. 4

Decision Tree for the Classification of Digital Technology Attitudes Using the Random Tree Algorithm

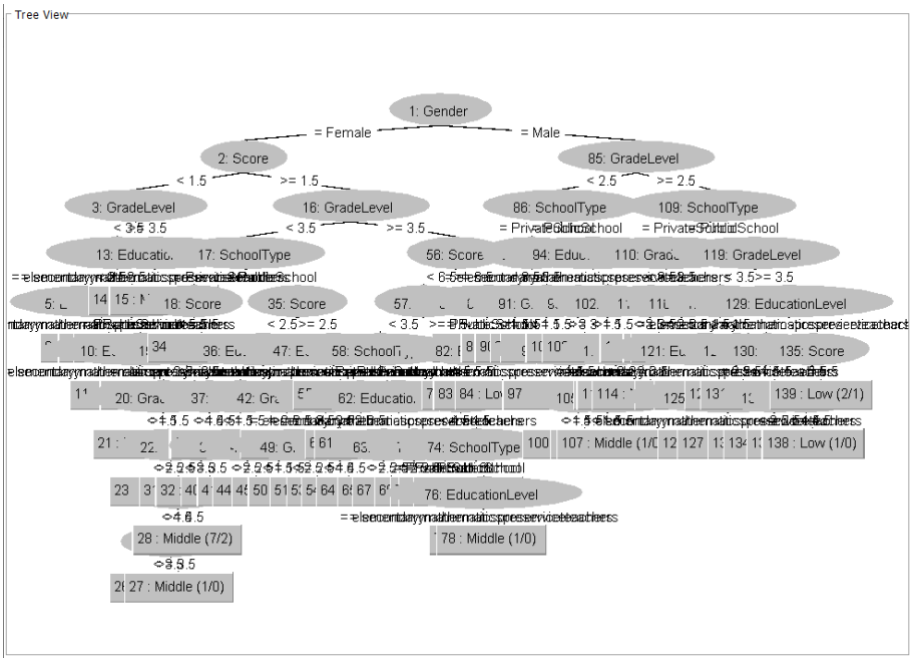


Figure 4 presents the branches generated by the Random Tree algorithm visually. According to this tree, it can be seen that gender is the variable that most affects the attitudes of mathematics pre-service teachers towards digital technology.

DISCUSSION, CONCLUSION AND RECOMMENDATİONS

The first problem of the research is to examine the attitudes of pre-service mathematics teachers towards digital technology according to some demographic variables by means of statistical methods.

The first sub-problem of the research is to determine whether there is a significant difference in math pre-service teachers' attitudes towards digital technology according to gender. In this direction, it is observed that there is no significant difference according to gender in the sub-dimensions of interest and willingness, social media, awareness of the importance of technology, and negative factors in pre-service teachers' attitudes towards digital technology. However, it is seen that there is a difference according to gender in the sub-dimensions of technology use, conscious use of technology, and use of technology for gaming. When the averages of technology usage, conscious technology usage, and gaming purpose usage were examined, a significant difference was found in favor of male pre-service teachers. Accordingly, it can be said that male pre-service teachers are more inclined to use technology in education due to their higher interest in technology. Barut's (2015) study supports the result of this study as it found that the attitude average of male teachers was higher than that of females in the education technology usage sub-dimension of the technology attitude scale. In the literature, it is stated that gender is an unchanging factor in access to technology, technology usage, and attitude towards technology in the studies conducted in the last thirty years (Abbis, 2008). In many studies conducted in recent years, such as Enoch and Soker (2006), Hoskins and Van Hooff (2005), Ong and Lai (2006), Zhou and Xu (2007), it has been found that men have more positive perceptions

towards technology than women. Similarly, studies by Sainz and Lopez Saez (2010), Birgin et al., (2010), Menzi et al., (2012), Özer (2018), Şahin and Arslan Namlı (2019) and Aksoğan and Bulut Özbek (2020) have also reached the same conclusion. Marpa (2021) stated in his study that male teachers have a more positive attitude towards the use of technology in mathematics education than female teachers. On the other hand, there are also studies that have found that female pre-service teachers have more positive attitudes towards technology than male pre-service teachers, and their attitude levels are higher (Yaman, 2007; Özarslan, et al., 2013; Metin et al., 2013; Dargut & Çelik, 2014; Gülen, 2021). There are also studies that show no significant difference in the attitudes of teachers and pre-service teachers towards technology according to gender (Deniz et al., 2006; Şimşek, 2015; Karasakaloğlu et al., 2011; Sipahioğlu, 2019; Arslan & Bilgin, 2020; Ardıç, 2021).

The second sub-problem of the study is to determine whether there is a significant difference in math pre-service teachers' attitudes towards digital technology based on their department. In this regard, it is seen that the attitudes of pre-service teachers towards digital technology do not show a significant difference based on their department. It can be said that the pre-service teachers studying in the Primary Mathematics Teaching and High School Mathematics Teaching departments have similar attitudes towards digital technology under similar conditions.

The third sub-problem of the study is to determine whether there is a significant difference in the digital technology attitudes of mathematics pre-service teachers according to their grade level. In this regard, it has been observed that the grade level of pre-service teachers does not lead to a significant difference in their attitudes towards digital technology. It can be said that the grade level of pre-service teachers is not a significant determinant in their attitudes towards digital technology. Similarly, studies conducted by Dargut and Çelik (2014), Yılmaz et al., (2014) and Şimşek (2015), who worked with pre-service teachers, have also shown that there is no significant difference between the grade levels of pre-service teachers and their attitudes towards technology use. In contrast to these findings, Şahin and Arslan Namlı (2019) found in their study that the technology competencies of pre-service teachers increased from first grade to fourth grade when looking at all sub-dimensions. Similarly, Aksoğan and Bulut Özbek (2020) concluded in their study that pre-service teachers in their final year of study had a higher perspective on technology and better technology usage skills compared to those in their first year of study. This is because pre-service teachers in their final year of study are closer to transitioning into their profession and use technology in their presentations until they reach the fourth grade. Therefore, they think more about using technology and develop their skills in this area.s

The fourth sub-problem of the study is to determine whether there is a significant difference in mathematics pre-service teachers' attitudes towards digital technology according to the type of university they attend. In this regard, while no significant difference is observed in the sub-dimensions of conscious use of technology, awareness of the importance of technology, negative factors, and gaming use of technology according to university type, a significant difference is observed in the sub-dimensions of interest and willingness, technology use, and social media use according to university type. When the averages in the sub-dimensions of interest and willingness, technology use, and social media use are examined, a significant difference is found in favor of pre-service teachers studying at foundation universities. One possible reason for this result could be the greater availability of technological equipment in foundation universities under current conditions. In addition, the financial situation of students studying at foundation universities may play a facilitating role in their access to technology. Abidin et al. (2018), in their study conducted in Indonesia, note that the individual use of technological tools by students or the use of a tool collectively by a group has an impact on attitudes. In contrast to this result, Gülen (2021) has found that the attitudes of preschool teachers towards the use of technology tools do not differ according to the type of university they graduated from.

The fifth sub-problem of the research is to determine whether there is a significant difference in mathematics pre-service teachers' attitudes towards digital technology according to their final grades in the computer science course. In this regard, it is observed that there is no significant difference in the sub-dimensions of interest and willingness towards digital technology, conscious use of technology, social media, knowing the importance of technology, and using technology for gaming according to the final grades in the computer science course, while there is a significant difference in the sub-dimensions of technology use and negative factors according to the final grades in the computer science course.

The second problem of the research is to examine, through data mining analysis, which variable is the most effective in determining the attitudes of mathematics pre-service teachers towards digital technology. The data obtained from the research produced many algorithms and visual results using the WEKA program used in data mining analysis. According to the branches generated by the Random Tree algorithm, it was concluded that gender is the most important variable affecting the attitudes of mathematics pre-service teachers towards digital technology. A meta-analyses reseach conducted by Cai, Z. et al., (2017) includes several descriptions of studies on gender differences in attitudes towards technology use, the studies suggest that there is a small but persistent gender gap in attitudes towards technology, with males generally holding more favorable attitudes than females. However, the gap has reduced slightly in some dimensions over the past two decades. The studies also highlight the need for a multi-faceted approach to studying attitudes towards technology use and suggest that social and educational environmental factors could contribute to reducing the gender gap (Cai et al., 2017).

The research was conducted with 440 mathematics pre-service teachers from a state university and a foundation university. In this context, more pre-service teachers from different universities could participate in the study to obtain more generalizable results. Especially, more in-depth studies can be cunducted regarding factors where significant meaningful differences are detected. One-on-one interviews, beyond revealing the attitudes of teacher candidates toward technology, can shed light on the factors underlying these attitudes and what causes them. For example, a study conducted only with female pre-service teachers can help reveal the causes and details of negative attitudes. Qualitative studies can be conducted by interviewing mathematics pre-service teachers one-on-one. With the help of qualitative studies, beyond determining the situation, the causes of the emerging attitudes can also be identified.

REFERENCES

Abidin, Z., Mathrani, A. & Hunter, R. (2018). Gender-related differences in the use of technology in mathematics classrooms Student participation, learning strategies and attitudes. *The International Journal of Information and Learning Technology, 35(4),* 266-284.

Abbis, J. (2008). Rethinking the "problem"of gender and IT schooling: Discourses in literature. *Gender and Education*, *20*(2), 153-165.

Akçay, H., Tüysüz, C., Feyzioğlu, B. & Uçar, V. (2007). Bilgisayar destekli kimya öğretiminin öğrenci başarısı ve tutumuna etkisine bir örnek: 'Radyoaktivite'. *Dokuz Eylül Üniversitesi Buca Eğitim Fakültesi Dergisi, 22,* 98-106.

Aksoğan, M. & Bulut Özek, M. (2020). Öğretmen adaylarının teknoloji yeterlilikleri ile teknolojiye bakış açısı arasındaki ilişki. *Gümüşhane Üniversitesi Sosyal Bilimler Enstitüsü Elektronik Dergisi, 11(2),* 301-311.

Alakoç, Z. (2003). Matematik Öğretiminde teknolojik modern öğretim yaklaşımları. *The Turkish Online Journal of Educational Technology, 2(1),* 1303-6521.

Ardıç, M. A. (2021). Ortaöğretim öğretmenlerinin eğitimde teknoloji kullanımına yönelik tutumlarının incelenmesi. *Cumhuriyet International Journal of Education, 10(*2), 649-675.

Ardies, J. (2015). *Students' attitudes towards technology: A cross-sectional and longitudinal study in secondary education.* University of Antwerpen.

Ardies, J., De Maeyer, S. & Gijbelds, D. (2013). Reconstructing the pupils attitude towards technology-survey. *Design and Technology Education: An International Journal*, *18*(1), 1360-1431.

Arslan, E. H. & Bilgin, E. A. (2020). Matematik öğretiminde teknoloji kullanımı ve video ile öğretimin teknoloji tutumuna etkisi. *Fen, Matematik, Girişimcilik ve Teknoloji Dergisi*, *3*(1), 41-50.

Aydemir, B. (2017). *Veri madenciliği yöntemleri kullanarak Meslek Yüksek Okulu öğrencilerinin akademik başarı tahmini.* [Yayınlanmamış yüksek lisans tezi]. Pamukkale Üniversitesi.

Bame, E., Dugger, W., Jr., De Vries, M. & McBee, J. (1993). Pupils' attitudes toward technology - PATT-USA. *The Journal of Technology Studies, 19(1)*, 40-48.

Barut, L. (2015). *Fen ve teknoloji öğretmenlerinin eğitimde teknoloji kullanımına yönelik tutumları ile bilgisayar öz yeterlik algıları arasındaki ilişki*. [Yayınlanmamış yüksek lisans tezi]. Kahramanmaraş Sütçü İmam Üniversitesi.

Birgin, O., Çoker, B. & Çatlıoğlu, H. (2010). Investigation of First Year Pre-service Teachers Computer and Internet Uses in Terms of Gender. *Procedia Social and Behavioral Sciences, 2*(2), 1588-1592.

Borba, M. C. (2021). The future of mathematics education since COVID-19: humans with media or humans with non living things. *Educational Studies in Mathematics, 108,* 385-400.

Büyüköztürk, Ş., Kılıç Çakmak, E., Akgün, Ö.E., Karadeniz, Ş. & Demirel, F. (2011). *Bilimsel araştırma yöntemleri*. Pegem Yayınları.

Cai, Z., Fan & Xitao, Du, J. (2017). Gender and attitudes toward technology use: A meta-analysis. *Computers & Education, 105,* 1-13.

Cabı, E. (2015). Dijital teknolojiye yönelik tutum ölçeği. *Kastamonu Eğitim Dergisi*, *24*(3), 1229-1244.

Dargut, T. & Çelik, G. (2014). Türkçe öğretmeni adaylarının eğitimde teknoloji kullanımına ilişkin tutum ve düşünceleri. *Ana Dili Eğitimi Dergisi (Journal of Tongue Education)*, *2*(2), 28–41.

Davies, J. & Brember, I. (2001). The closing gap in attitudes between boys and girls: A 5-year longitudinal study. Educational Psychology: An International Journal Of Experimental. *Educational Psychology, 21*(1), 103–114.

Deniz, S., Görgen, İ. & Şeker, H. (2006). Tezsiz yüksek lisans öğretmen adaylarının teknolojiye yönelik tutumları. *Eurasian Journal of Educational Research, 23,* 62-71.

Ernest, P. (2004). Images of mathematics, values, and gender. In S. Johnston-Wilder & B. Allen (Eds.), *Mathematics education: Exploring the culture of learning.* Routledge.

Enoch, Y. & Soker, Z. (2006). Age, gender, ethnicity and the digital divide: University students' use of web-based instruction. *Open Learning*, *21*(2), 99-110.

Flores, A. (2002). Learning and teaching mathematics with technology. *Teaching Children Mathematics*, 308-310.

Ganesh, A., Palmer, M. & Kann, K. (2021). What Would a Teacher Do? Predicting Future Talk Moves. doi:https://doi.org/10.48550/arXiv.2106.05249

Göktepe Körpeğlu, S. & Göktepe Yıldız, S. (2023). Comparative analysis of algorithms with data mining methods for examining attitudes towards STEM fields. *Education and Infırmation Technologies, 28*, 2791-2826.

Gülen, M. (2021). *Okul öncesi öğretmenlerinin teknolojik araç gereç kullanımına yönelik tutumlarının incelenmesi*. [Yayınlanmamış yüksek lisans tezi]. Fatih Sultan Mehmet Private Üniversitesi.

Hoskins, S. L. & Van Hooff, J. C. (2005). Motivation and ability: Which students use online learning and what influence does it have on their achievement? *British Journal of Educational Technology, 36*(2), 177-192.

Karasakaloğlu, N., Saracaloğlu, S. A. & Uça, S. (2011). Türkçe öğretmenlerinin teknoloji tutumları ile bilgi teknolojilerini kullanma düzeylerinin incelenmesi. *Mersin Üniversitesi Eğitim Fakültesi Dergisi, 7*(2), 26-36.

Krathwohl, D., Bloom, B. & Bertram, B. (1964). *Taxonomy of educational objectives: Handbook II affectuve domain*. David McKay Company, Inc.

Marpa, El. P. (2021). Technology in the Teaching of Mathematics: An Analysis of Teachers' Attitudes during the COVID-19 Pandemic. *International Journal on Studies in Education*, *3*(2), 92-102.

Marzilli, C., Delello, J., Marmion, S., McWhorter, R., Roberts, P. & Marzilli, T. S. (2014). Faculty Attitudes Towards Integrating Technology and Innovation. *International Journal on Integrating Technology in Innovation, 3*(1).

Menzi, N., Önal, N. & Çalışkan, E. (2012). Mobil teknolojilerin eğitim amaçlı kullanımına yönelik akademisyen görüşlerinin teknoloji kabul modeli çerçevesinde incelenmesi. *Ege Eğitim Dergisi, 1*(13), 40-55.

Metin, M., Birişçi, S. & Coşkun, K. (2013). Öğretmen adaylarının öğretim teknolojilerine yönelik tutumlarının farklı değişkenler açısından incelenmesi. *Kastomunu Eğitim Dergisi, 21*(4), 1345-1364.

Ong, C. S. & Lai, J. Y. (2006). Gender differences in perceptions and relationships among dominants of e-learning acceptance. *Computers in Human Behavior, 22*(5), 816-829.

Özarslan, M., Çetin, G. & Sarıtaş T. (2013). Biyoloji, fizik ve kimya öğretmen adaylarının bilgi ve iletişim teknolojilerine yönelik tutumları. *Türk Fen Eğitimi Dergisi, 10*(2), 85-100.

Özer, Z. (2018). An investigation of prospective ELT teachers' attitudes towards using computer technologies in foreign language teaching. *Journal of Language and Linguistic Studies, 14*(1), 328-341.

Reychav, I., McHaney, R. & Burke, D. D., The relationship between gender and mobile technology use in collaborative learning settings: An empirical investigation. *Computers & Education, 113*, 61-74.

Sáinz, M. & López-Sáez, M. (2010). Gender differences in computer attitudes and the choice of technology-related occupations in a sample of secondary students in Spain. *Computers & Education, 54*(2), 578-587.

Sipahioğlu, S. (2019). *Fen Bilimleri öğretmenlerinin eğitimde teknoloji kullanımına yönelik tutumlarının çeşitli değişkenlere göre incelenmesi.* [Yayınlanmamış yüksek lisans tezi]. Atatürk Üniversitesi.

Şahin, M. C. & Arslan Namlı, N. (2019). Öğretmen adaylarının eğitimde teknoloji kullanma tutumlarının incelenmesi. *Türkiye Sosyal Araştırmalar Dergisi, 23*(1), 95-112.

Şimşek, Ü. (2015). *Sosyal bilgiler öğretmen adaylarının eğitimde teknoloji kullanımına ilişkin tutum ve görüşlerinin incelenmesi*. [Yayınlanmamış yüksek lisans tezi]. Aksaray Üniversitesi.

Üstün, A. & Akman, E. (2015). Özel okul öğretmenlerinin eğitimde teknoloji kullanımına ilişkin tutum ve görüşleri. *Journal of Educational Science, 3*(4), 94-103.

Yaman, H. (2007). Türkçe öğretmeni adaylarının 'öğretim teknolojileri ve materyal geliştirme' dersi bağlamında Türkçe öğretiminde teknoloji kullanımına ilişkin yeterlilik ve algıları. *İstanbul Üniversitesi Hasan Ali Yücel Eğitim Fakültesi Dergisi, 4*(1), 57-71.

Yavuz, S. & Coşkun, E. (2008). Attitudes and perceptions of primary teaching through the use of technology in education. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 34*, 276-286.

Yılmaz, M., Üredi, L. & Akbaşlı, S. (2015). Sınıf öğretmeni adaylarının bilgisayar yeterlilik düzeylerinin ve eğitimde teknoloji kullanımına yönelik algılarının belirlenmesi, *International Journal of Humanities and Education, 1*(1), 105-121.

Zheng, L., Long, M., Zhong, L. & Gyasi, J. F. (2022) The effectiveness of technology-facilitated personalized learning on learning achievements and learning perceptions: a meta-analysis. *Education and Information Technologies, 27*, 11807-11830.

Zhou, G. & Xu, J. (2007). Adoption of educational technology: How does gender matter? *International Journal of Teaching and Learning in Higher Education, 19*(2), 140-153.

GENİŞLETİLMİŞ ÖZET

Giriş

Teknolojinin matematik eğitiminde de yeri ve önemi son yıllarda artmıştır. Öncelikle, teknoloji matematik kavramlarının öğretiminde yeni ve etkileşimli yollar sunarak, onu öğrenciler için daha ilgi çekici ve anlaşılır hale getirmek amacıyla kullanılmaktadır. Öğrencilerin matematiksel kavramları görselleştirmelerine, matematiksel fikirleri keşfetmelerine ve bunlarla deneyler yapmalarına ve öğrenme materyallerine kendi hızlarında erişmelerine yardımcı olmak için bilgisayar yazılımı, çevrimiçi kaynaklar ve eğitim uygulamalarını kullanmalarına imkan vermektedir. Böylece, teknoloji, öğrencilerin zorluk çektiği kavramları daha iyi anlamalarına yardımcı olabileceği gibi, anında geri bildirim ve kişiselleştirilmiş öğrenme deneyimleri sunabilme yanı da hem öğrenci hem öğretmenler için tercih edilebilecek bir özelliğidir. Ayrıca teknoloji matematik kaynaklarına kolay ve ekonomik olarak erişimi sağlayacağından, öncelikle sınırlı olanağa sahip okullar ve öğrenciler olmak üzere tüm öğretmen ve öğrenciler için eğitimdeki boşluğu kapatmaya, zenginleştirmeye yardımcı olabilecek, eğitimin kalitesini arttıracaktır. Genel olarak, teknoloji, hem öğretmen hem de öğrenciler için öğrenme deneyimini ve sonuçlarını büyük ölçüde geliştirme potansiyeline sahiptir.

Alanyazına bakıldığında matematik öğretmen adaylarının dijital teknolojiye yönelik tutumlarını etkileyen değişkenlerin belirlenmeye çalışıldığı çok az sayıda çalışmaya rastlanılmıştır. Buradan yola çıkarak araştırmada istatistiksel yöntemler ile matematik öğretmen adaylarının dijital teknolojiye yönelik tutumlarının cinsiyet, bölüm, sınıf düzeyi, üniversite türü,

bilişim teknolojileri dersi dönem sonu not ortalamalarına göre farklılaşıp farklılaşmadığı incelenmiş, veri madenciliği algoritmalarıyla da matematik öğretmen adaylarının dijital teknolojiye yönelik tutumlarının hangi değişkenler üzerinde etkili olduğu ortaya konmuştur. Böylece alandaki boşluğun doldurulmasına yardımcı olunacağı düşünülmektedir. Çalışmada aşağıdaki problemlere cevap aranmıştır.

1) İstatistiksel yöntemlere göre matematik öğretmen adaylarının dijital teknolojiye yönelik tutum ölçeğinden aldıkları puanlar arasında;
- Cinsiyet,
- Bölüm,
- Sınıf düzeyi,
- Üniversite türü,
- Bilişim teknolojileri dersi dönem sonu not ortalamalarına göre anlamlı farklılık var mıdır?

2) Veri madenciliği algoritmalarına göre, matematik öğretmen adaylarının dijital teknolojiye yönelik tutumlarını belirlemede hangi değişkenler etkilidir?

Yöntem

Bu çalışmada, öğretmen adaylarının dijital teknolojiye yönelik tutumlarının demografik değişkenlere göre farklılıklarının incelenmesi amacıyla nicel araştırma türlerinden genel tarama modeli kullanılmıştır. Çalışmanın evrenini Türkiye'de İstanbul ilinde bulunan Biruni Üniversitesi İlköğretim Matematik öğretmenliği öğrencileri ile İzmir ilinde bulunan Dokuz Eylül Üniversitesi Lise Matematik ve ilköğretim Matematik öğretmenliği öğrencileri oluşturmaktadır. Araştırmanın veri setini, çalışmaya katılan 440 matematik öğretmen adayının anket sonuçları oluşturmaktadır. Veriler araştırmacılar tarafından veri toplama araçları aracılığıyla toplanmıştır. Veri setinde matematik öğretmen adaylarının dijital teknolojiye yönelik tutumlarını ortaya koymak için bağımlı değişken dijital teknolojiye yönelik tutum, demografik değişkenler ise cinsiyet, bölüm, sınıf düzeyi, üniversite türü ve bilişim teknolojileri dersi dönem sonu not ortalamasıdır.

Verilerin istatistiksel analizi için SPSS 20 paket programından yararlanılmıştır. Araştırma kapsamında çalışma grubunun araştırılan değişkenlere ilişkin frekans dağılımı, faktör analizi, güvenirlik testi, Kolmogorov-Smirnov normal dağılım testi yapılmıştır. Veriler normal dağılım göstermediği için nonparametrik testler olan Mann Whitney U testi ve Kruskal Wallis testi ile veriler analiz edilmiştir. Matematik öğretmen adaylarının dijital teknolojiye yönelik tutumlarında hangi değişkenlerin etkili olduğunu belirlemede veri madenciliği yazılımı olan 3.8.4 versiyonlu WEKA programı kullanılmıştır. WEKA, Yeni Zelanda Waikato Üniversitesi tarafından geliştirilen birçok sınıflandırma tekniği içeren açık kaynaklı bir yazılımdır (Aydemir, 2017).

Sonuçlar ve Tartışma

Araştırmanın birinci alt problemi matematik öğretmen adaylarının dijital teknolojiye yönelik tutumlarının cinsiyete göre anlamlı bir farklılık gösterip göstermediğinin tespit edilmesidir. Bu doğrultuda, öğretmen adaylarının dijital teknolojiye yönelik tutumlarının ilgi ve isteklilik, sosyal medya, teknolojinin önemini bilme ve olumsuz faktörler alt boyutlarında cinsiyete göre anlamlı farklılık görünmezken, teknoloji kullanımı, teknolojinin bilinçli kullanımı ve oyun amaçlı kullanımı alt boyutlarında cinsiyete göre farklılık gösterdiği görülmektedir. Teknoloji kullanımı, teknolojinin bilinçli kullanımı ve oyun amaçlı kullanımı alt boyutlarında ortalamalara bakıldığında erkek öğretmen adaylarının lehine anlamlı farklılık bulunmuştur. Bu sonuca göre, erkek öğretmen adaylarının teknolojiye ilgilerinin daha fazla olmasından dolayı eğitim alanında teknoloji kullanımına daha eğilimli olduğu söylenebilir.

Araştırmanın ikinci alt problemi matematik öğretmen adaylarının dijital teknolojiye yönelik tutumlarının bölüme göre anlamlı bir farklılık gösterip göstermediğinin tespit edilmesidir. Bu doğrultuda, öğretmen adaylarının dijital teknolojiye yönelik tutumlarının bölüme göre anlamlı

bir farklılık göstermediği görülmüştür. İlköğretim Matematik öğretmenliği ve Lise Matematik öğretmenliği bölümlerinde okumakta olan öğretmen adaylarının dijital teknolojiye yönelik tutumlarının benzer şartlara sahip oldukları söylenebilir.

Araştırmanın üçüncü alt problemi matematik öğretmen adaylarının dijital teknolojiye yönelik tutumlarının sınıf düzeyine göre anlamlı bir farklılık gösterip göstermediğinin tespit edilmesidir. Bu doğrultuda, öğretmen adaylarının dijital teknolojiye yönelik tutumlarının sınıf düzeyine göre anlamlı farklılığa yol açmadığı görülmüştür. Yani öğretmen adaylarının sınıf düzeyleri, dijital teknolojiye yönelik tutumlarında anlamlı bir belirleyici değildir denilebilir.

Araştırmanın dördüncü alt problemi matematik öğretmen adaylarının dijital teknolojiye yönelik tutumlarının üniversite türüne göre anlamlı bir farklılık gösterip göstermediğinin tespit edilmesidir. Bu doğrultuda, öğretmen adaylarının dijital teknolojiye yönelik tutumlarının teknolojinin bilinçli kullanımı, teknolojinin önemini bilme, olumsuz faktörler ve oyun amaçlı kullanım alt boyutlarında üniversite türüne göre anlamlı farklılık görünmezken, ilgi ve isteklilik, teknoloji kullanımı ve sosyal medya alt boyutlarında üniversite türüne göre anlamlı farklılık gösterdiği görülmektedir. İlgi ve isteklilik, teknoloji kullanımı ve sosyal medya alt boyutlarında ortalamalara bakıldığında vakıf üniversitesinde okumakta olan öğretmen adaylarının lehine anlamlı farklılık bulunmuştur. Günümüz koşullarında teknolojik araç gereç donanımının vakıf üniversitelerinde daha çok bulunması bu sonucun olası nedenlerinden biri olabilir. Ayrıca, vakıf üniversitesinde okuyan öğrencilerin maddi durumları teknolojiye ulaşımlarını kolaylaştırıcı rol oynuyor olabilir.

Araştırmanın beşinci alt problemi matematik öğretmen adaylarının dijital teknolojiye yönelik tutumlarının bilişim teknolojileri dersi dönem sonu not ortalamalarına göre anlamlı bir farklılık gösterip göstermediğinin tespit edilmesidir. Bu doğrultuda, öğretmen adaylarının dijital teknolojiye yönelik tutumlarının ilgi ve isteklilik, teknolojinin bilinçli kullanımı, sosyal medya, teknolojinin önemini bilme ve oyun amaçlı kullanım alt boyutlarında bilişim teknolojileri dersi dönem sonu not ortalamalarına göre anlamlı farklılık görünmezken, teknoloji kullanımı ve olumsuz faktörler alt boyutlarında bilişim teknolojileri dersi dönem sonu not ortalamalarına göre anlamlı farklılık gösterdiği görülmektedir.

Araştırmanın ikinci problemi, matematik öğretmen adaylarının dijital teknolojiye yönelik tutumlarını belirlemede hangi değişkenin en etkili olduğunu veri madenciliği analizine göre incelemektir. Veri madenciliği analizinde kullanılan WEKA programı ile araştırmadan elde edilen veriler pek çok algoritma ve görsel sonuçlar ortaya çıkarmıştır. Random Tree algoritmasının ürettiği dallara göre, matematik öğretmen adaylarının dijital teknolojiye yönelik tutumlarını etkileyen en önemli değişkenin cinsiyet olduğu sonucuna ulaşılmıştır.

Araştırma bir devlet üniversitesi ve bir vakıf üniversitesi olmak üzere 440 matematik öğretmen adayı ile gerçekleştirilmiştir. Bu bağlamda daha farklı üniversitelerden öğretmen adayları çalışmaya katılarak daha genellenebilir sonuçlar elde edilebilir. Sadece tutum farklılığı gösteren faktörler üzerinde durularak ve bu alanlarda daha derinlemesine sorular sorularak tutum farklılıklarının alt boyutları ortaya çıkarılmaya çalışılabilir.