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## The Relationship between Technology Literacies and Proactive Personalities of Secondary School Mathematics Teachers

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### Abstract

The aim of this study is to determine the level of technology literacy and proactive personality of secondary school mathematics teachers, the relationship between technology literacy and proactive personalities, and how much of the proactive personality is explained by the technology literacy, according to the perceptions of secondary school mathematics teachers. The study was designed around a relational survey model, which is a quantitative research technique. The population of the study consisted of mathematics teachers working in secondary schools in Turkey and the sample was 380 secondary school mathematics teachers selected by simple random sampling method. Technology Literacy Scale and Proactive Personality Scale were used as data collection instruments. Descriptive statistics, correlation and regression analyses were used to analyse the data. The secondary school mathematics teachers' perceptions about technology literacy and proactive personality were found to be high. In addition, there was a moderate level positive and significant correlation between technology literacy and proactive personality of the secondary school mathematics teachers. Finally, the proactive personality of secondary school mathematics teachers explained their technology literacy at 30.7% level.

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### Introduction

International examinations such as PISA and TIMSS allow countries to compare their achievements in education and to identify the factors affecting their success. PISA evaluates countries in mathematics, reading and science, and TIMSS measures countries' achievement in mathematics and science. Success or failure in mathematics in international examinations is effective in shaping the educational policies of countries because countries with successful individuals in mathematics are one step ahead of other countries on the way to becoming a leading power in science, technology and economy. In this sense, in order to have successful mathematicians, countries are looking for ways to have qualified mathematics teachers.

Mathematics teachers are of great importance in terms of raising individuals who are needed socially, culturally, economically, scientifically and technologically, and it is also essential that they perform their duties effectively and efficiently with their knowledge and skills in teaching the field (Sisman & Acat, 2003). For their mathematics lessons, besides the basic skills they need to have, the teachers should also have the 21st century

skills such as creative and critical thinking, problem solving, having high communication skills, being open to new ideas, being flexible and adaptable, being aware of responsibilities, being self-directed and taking initiative, having developed social and cultural skills, having productive and leadership skills, being able to cooperate with others, being able to use technology to reach information, and knowing how to reach the required knowledge (Bergeson & Beschoner, 2020; Norton-Meier, Hand, & Ardasheva, 2013; Uluyol & Eryilmaz, 2015). While there is no universal view of what the 21st century skills are, some major companies summarize the 21st century skills with 13 competences under three headings. These include learning and innovation skills, creative thinking, critical thinking, problem solving, communication and collaboration, life and career skills, flexibility and harmony, self-direction, social skills, productivity and accountability and leadership, knowledge, media and technology skills, information, media and technology literacy (Partnership for 21st Century Learning, 2019).

The concept of technology literacy is one of the 21st century skills to adapt to changing conditions. Technology is the process of making changes in nature to meet the demands and needs of people (Garmire & Pearson, 2006). Technology not only refers to a product/object, it also refers to a dynamic cultural phenomenon that includes social actions, worldviews and social structuring (Dobres & Hoffman, 1994). The existence of technology in human life is getting more and more salient each day. Therefore, it is necessary to have basic knowledge and skills related to various dimensions of technology in human life, to benefit from it effectively, to be knowledgeable about the equipment and technical information that will shape the future, and to improve the current technology (Yigit, 2011). It is important for mathematics teachers to understand the meaning of concepts such as technology, technology education and technology literacy in a correct way, to integrate technology effectively into the courses, and to create more qualified classroom environments. Thanks to successful technology education and technology-supported education, it is ensured that the individual comprehends the relation of technology with nature, society and culture while some criteria are also provided to enable individuals and institutions to benefit from technology consciously (Kelani, 2009). The main objective of technology education is to increase the technology literacy of societies (Yilmaz & Horzum, 2005). Technology literacy is the ability to use digital technology to access, integrate, manage, evaluate and produce information in order to take part in society (International ICT Literacy Panel, 2002), and to explore the information in the digital environment and to ensure its transmission (Eryilmaz & Uluyol, 2015). In other words, technology literacy refers to the ability to use, understand, evaluate and manage technology (Yigit, 2011). As a result of increasing global competition and the need for continuous innovation, organizations expect their employees to take initiatives in their jobs (Grant & Ashford, 2008). Some of the most important behaviours that stand out among the 21st century skills are knowing responsibilities, being self-directed and taking initiative. Today, it is no longer enough to fulfil the given tasks by employees. Nowadays, there is a desire to work with employees who demonstrate a high level of performance in their jobs (Parker, Bindl, & Strauss, 2010). This desire highlights proactive personality in the 21st century. Proactivity, which has not yet taken its place in the Turkish Language Society Dictionary, is defined as “*action- and result-oriented behaviours that are displayed to control the events rather than just waiting for them to be resolved by themselves*” in Business Dictionary; and “*taking action by making changes in time*” in Cambridge Dictionary. Proactivity is a personality trait that motivates and individual and leads him or her to take action.

Bateman and Crant (1993) elaborated the structure of proactive personality through several behavioural outcomes such as extroversion, more participation in learning activities, more success-orientedness, and showing conscious behaviour. Parker, Williams, and Turner (2006) defined proactivity as activities that a person implements in order to change the future, taking into account the situation s/he initiated or encountered, with the purpose of achieving his/her change and development. In contrast with proactive people, reactive individuals wait for other people to take action and for the external factors to create a change by exhibiting a passive attitude (Bateman & Crant, 1993). There are three sub-stages in a proactive behavior. In the first stage, the behaviour is initiated by the individual himself/herself. In the second stage, the individual exhibiting the behavior should have an anticipation and in the last stage behavior should serve for a change (Aybatan, 2018). Considering the definitions of proactivity, proactive behaviours and proactive personality traits, it is believed that teachers with proactive personality are essential for school organizations.

This idea is supported by the findings of Hotaman (2010). According to Hotaman (2010), the personality traits of teachers are as important as their field expertise and teaching skills. In the proactive personality, as in the motivational factors of Herzberg (1959), mental or behavioural tendencies come from the innerside of the individual (Parker, Williams, & Turner, 2006). According to Herzberg (1959), individuals and organizations cannot achieve their goals without motivational factors. Parker, Williams, and Turner (2006) stated that proactive personality triggers motivation in the individual. For this reason, it can be thought that the high level of proactive traits are essential for secondary school mathematics teachers to create change in mathematics courses, not to make just excuses related to external factors in the process, and to take responsibility in the teaching process. Besides, it can be considered that teachers with proactive personality will be more entrepreneurial about having the 21st century skills, and they will develop a more conscious attitude towards technology literacy.

How to integrate emerging technologies into geometry and mathematics education processes and how to transfer them to learning environments is a critical consideration that can affect the success of education. Technology has been regarded as a tool for mathematics teaching and learning (Daher, Baya'a & Anabousy, 2018; Serhan & Almeqdadi, 2020). At the same time, the issue of how to increase the competencies of teachers, who are the main implementers of new technological approaches, is very important in terms of raising the human profile that will meet the requirements of the age (Karaarslan, Boz, & Yildirim, 2013). Teachers play a key role in integrating technology into education (Instefjord & Munthe 2017; Kim et al., 2013; Lawless & Pellegrino 2007; Tondeur et al., 2012). For this reason, teachers and teacher educators should be technologically literate (Agyei & Voogt, 2011; Sang, Valcke, van Braak, & Tondeur, 2010; Tondeur, van Braak, Siddiq, & Scherer, 2016; Uerz, Volman, & Kral, 2018). The qualities of being technologically literate may vary according to the socio-cultural context. For example, the characteristics of being technologically literate in a tribe in New Guinea will not correspond to the same characteristics belonged by an individual who is technologically literate in Sydney, Australia (Ingerman & Collier Reed, 2010).

Therefore, technology literacy should be interpreted depending on the existing context rather than some general characteristics (Ingerman & Collier Reed, 2010). Molebash (2004) found that the inadequacies experienced in

providing technology-integrated activities in teacher training institutions had a negative impact on teachers' utilization of technology and integration of technology in their courses. Callava (2007) stated that despite the positive attitudes towards computer technology in education faculties, these attitudes are not reflected in the practical application rates and the use of computers is limited. Li (2007) in his study with mathematics and science teachers revealed that teachers have a negative attitude towards using technology at school.

When studies on proactive personality are examined, it is seen that there are very few studies in which proactive personalities of teachers are analysed (Erdogan & Bauer, 2005; Li, Liu, Liu, & Wang, 2017; Schwarzer, 1999; Yucel, Kocak, & Cula, 2010). Erdogan and Bauer (2005), in their study with teachers working in primary and secondary schools, found that proactive personality and job satisfaction were high in the organizations where there is a high level of staff-organization harmony. In the study conducted with teachers by Cerit and Akgun (2013), proactive behavior levels of teachers were found below medium. According to Cetin (2011), the level of proactive behavior of individuals having high self-efficacy beliefs increases and they are more active in expanding their individual networks. Crant (2000) stated that proactive behavior leads to an increase in organizational effectiveness. Bozbayindir and Alev (2017) reported a positive correlation between proactive personality and openness to change.

In addition, Bozbayindir and Alev (2017) remarked that persistence predicted proactive personality directly and significantly. Bledow and Frese (2009) noted that higher self-efficacy leads to more proactive behavior. In line with the research conducted, teachers with proactive personality traits play a vital role in the formation of effective school cultures as they will be more willing to help the school organizations to realize their goals, they will be more responsible in this regard and they will develop themselves further. Developments in technology have also led to the changes in the roles of mathematics teachers in teaching-learning environment. Mathematics teachers should not only know how to use computers, but also effectively integrate technology into the learning process and create environments where students can make the most of technology (Akpınar, 2003).

### **Why is Proactive Personality Important for Math Teachers?**

Proactivity is not a feature of people who criticize, but do something for a solution; it is a feature of people who guide, try to be a part of the solution, focus on what they can do, are intrinsically motivated and not dependent on external factors by being in search of a solution of the problems. Bateman and Crant (1993) highlighted the qualities of making efforts to achieve goals, using initiative and changing something, while defining the characteristics of individuals with proactive personality in organizations (school, etc.). Covey (2004) stated in his book entitled "*The Seven Habits of Highly Effective People*" that the first of seven habits of highly influential people is "*being proactive*."

Scientific and technological changes cause major reform attempts in the design of learning environments. The support and commitment of the teacher to the process is very crucial for these initiatives in education to produce effective results (Belschak, Den Hartog, & Fay, 2010; Smith, 2015). Schools are assigned missions to carry out activities that require adapting to changes and developing conditions, and to meet expectations in view of

increasing demands in a competitive environment (De Dreu, 2006; Organisation for Economic Cooperation and Development [OECD], 2006; Somech & Wenderow, 2006). These missions require teachers, who are important elements of the school culture, to have high levels of proactive behavior (Canter & Canter, 2001; DiPaolo & Hoy, 2005).

In the project titled as "*Partnership for 21st Century Skills*", implemented in 21 states in the USA and supported by 33 institutions with the participation of teachers, academics and business leaders, mathematics is considered as one of the main disciplines of the 21st century. The proactive structures of mathematics teachers who can design effective classroom environments are viewed as essential for mathematics lesson, which is one of the three main exam areas (reading, science and mathematics) in international exams such as PISA and TIMSS.

Proactive mathematics teachers can stand stronger in the face of uncertainties and changes and can participate effectively in the change process. As Frese and Fay (2001) stated, math teachers with a proactive personality, who tend to evaluate opportunities, take action, and work with determination until they get what they want, are of great importance in designing mathematics teaching-learning processes effectively. Similarly, Fuller and Marler (2009) stressed that proactive personality and professional performance are in a positive relationship. Bandura's theory of mutual determination, Kanfer's self-regulation theory and Flavell's metacognition approach emphasize the regulation of the learning process and social environment of individuals. This is in line with the behavior of proactive mathematics teachers. Li et al. (2017) revealed that there is a significant relationship between proactive personality and teachers' innovative work behaviors, and proactive personality positively affects innovative work behaviors. In other words, proactive math teachers are open to innovations in math learning environments.

In Realistic Mathematics Education (RME) approach developed by Treffers (1987; 1991) and Freudenthal (1991), there are six basic principles to guide teachers while organizing the learning process (Van den Heuvel-Panhuizen & Drijvers, 2014). These are as follows: (1) Reality, (2) Intertwinement, (3) Guidance, (4) Activity, (5) Level, (6) Interactivity. In line with the principles of didactic phenomenology in mathematics learning supported by RME, what is expected from mathematics teachers is to guide students to reach a solution or concept by leading them through interdisciplinary real-life problems. Van den Heuvel-Panhuizen and Drijvers (2014) emphasized in the RME approach that mathematics teachers should have proactive skills and the potential to steer this by predicting the situations to be experienced in the problem solving process. Wagner (2008) maintained that there are seven basic skills needed in the 21st century and one of them is entrepreneurship. Being an entrepreneur is one of the basic proactive behaviors. The abovementioned studies indicate that being proactive is one essential competency of mathematics teachers in the 21st century.

### **Why Technology Literacy is Important for Math Teachers?**

One of the major goals of teaching today is to create a technologically literate society (Lee, 2004). Trilling and Fadel (2009) emphasized digital literacy, which is an indispensable part of technology literacy, as a 21st century teacher and student skill. Wolfinger (2000) and the American National Research Council (1996) argued that

teachers play an important role in training children as technologically literate individuals. It also encourages science, technology and mathematics teachers to demonstrate skills such as scientific scepticism, being open to and curious about new ideas, as a model in teaching-learning processes. Learning environments need to be changed and developed in line with technological developments. Technology literacy and technology-supported environments which offer rich environments in the learning process are necessities for all teachers (Prevenzo, Brett, & McCloskey, 1999).

Shulman's (1986) "*Pedagogical Content Knowledge*" learning approach has been updated as the Technological Pedagogical Content Knowledge [TPCK] learning approach today by Mishra & Koehler (2006) and Koehler & Mishra (2008). TPCK learning approach shows that technology knowledge of mathematics teachers is also very important for mathematics learning environments. In the TPCK learning approach, it is stated that technology is integrated with pedagogical and field knowledge, and these three types of information affect each other, and provide an opportunity for more effective learning process (Angeli & Valanides 2009; Graham, Burgoyne, Cantrell, Smith, Clair, & Harris, 2009; Mishra & Koehler, 2006). Leatham (2007), Hastings (2009) and Wachira & Keengwe (2011) regarded the lack of knowledge and self-confidence in using technology in mathematics learning as one of the barriers of mathematics teachers in technology integration. Research indicates that mathematics teachers should be technologically literate in the 21st century.

Lingefjård (2000), Hidiroglu and Bukova Guzel (2017) revealed the active role of technology in the mathematical modeling assisted learning process, taking into account the positive opinions regarding the use of technology in mathematics education. Dynamic mathematics and geometry software used in the process of learning mathematics serve as a bridge in establishing relationships between geometric and algebraic representations (Hidiroglu & Bukova Guzel, 2014). Hohenwarter, Hohenwarter, Kreis & Lavicza, (2008) and Galbraith & Stillman (2006) also mentioned that mathematics teachers need to integrate dynamic mathematics and geometry software effectively in order to create more quality teaching/learning environments. Hidiroglu and Ozkan Hidiroglu (2016) underlined that HTTM (History / Theory / Technology / Modeling) mathematics learning process plays an important role in developing computer software, video, animation and photographs, developing mental skills and supporting conceptual learning. It is also emphasized that mathematics teachers should be prepared for all the different scenarios that may arise during the HTTM learning process. This is a key factor for mathematics teachers both in creating an effective teaching-learning process and in making better evaluations of students (Hidiroglu & Ozkan Hidiroglu, 2016). Technologically literate teachers will be more successful in providing such environments.

Another new learning approach is STEM education. STEM education is an interdisciplinary approach that covers the entire educational process from pre-school education to higher education (Gonzalez & Kuenzi, 2012). STEM education includes technology and engineering fields based on science and mathematics disciplines (Bybee, 2010). According to the way STEM is handled in the learning environment, it is possible to talk about silo (disciplines are treated separately), grounded (at least one area supports the other) and holistic (all disciplines come together) approaches (Roberts & Cantu, 2012). Hom (2014) noted that STEM education is an integrated approach that combines science, technology, engineering and mathematics disciplines with different

subjects in real life contexts simultaneously. The aims of STEM education are as follows: (1) to increase science and technology literacy, (2) to gain problem solving and critical thinking skills, (3) to increase awareness towards engineering and technology, (4) to increase interest in engineering careers and to produce innovations that support the economic development of countries (Thomas, 2014).

It is required for science, technology and mathematics teachers, who will design and implement the STEM learning process to educate future people, to have technology literacy skills (Miaoulis, 2009; Moran, 2002). At the same time, teachers should be able to enable children to discover and reflect their theories in well-planned STEM practices, be aware of different solution strategies and processes, and create effective learning experiences. It is seen that an important emphasis is placed on both the proactive role of mathematics teachers and technology literacy in both the technology and mathematical modeling supported learning processes and mathematics teaching studies in STEM learning environments. As a similar example, in the project titled “*Partnership for the 21st Century Skills*”, the main skills of the 21st century include proactive behaviors such as innovation, openness to change (flexibility), entrepreneurship, responsibility, self-direction, information and communication technologies (ICT) literacy and technology literacy skills.

All these studies reveal that the 21st century math teachers' proactive behavior and technological literacy skills are crucial. The absence of a study for the relationship between these two variables is the most basic element that makes this study original. In the literature, there has been no study on the relationship between the technology literacy, proactive personalities of the mathematics teachers and the proactive personalities of technology literacy. In this sense, it is believed that the study will contribute to the literature. The aim of this study is to determine the secondary school mathematics teachers' perceptions about their technology literacy and proactive personality, and to examine the relationship between perceptions about their technology literacy and perceptions about their proactive personality. In this respect, the following sub-problems are determined:

- 1) What are the perceptions of the secondary school mathematics teachers about their level of technology literacy?
- 2) What are the perceptions of the secondary school mathematics teachers about their level of proactive personalities?
- 3) Is there a significant relationship between secondary school mathematics teachers' perceptions of technology literacy and proactive personalities?
- 4) Are secondary school mathematics teachers' perceptions of their proactive personality a significant predictor of their perceptions of their technology literacy?

## **Method**

### **Research Design**

The study is a correlational survey conducted with a quantitative research approach. According to Karasar (2009), the research model, which aims to determine the existence of variation between variables and its degree, is a relational screening model. In this study, the correlational survey model was used to determine if there is a relationship between technology literacy and proactive personalities of secondary school mathematics teachers,



and the degree of it, if any. In the study, it is tried to be determined whether the variables change together, and if there is a change, the level of the change, if any.

### Study Group

The population of the study was comprised of secondary school mathematics teachers working in different regions of Turkey during 2018-2019 academic year. A simple random sampling method was used to select the sample of the study. A total of 385 people were reached and five data were considered invalid. The study was carried out with 380 secondary school mathematics teachers. A sufficient number of sample was reached by using the sample size table of Gay and Airasan (2000). Demographic characteristics of the teachers who participated in the study are given in Table 1.

Table 1. Demographic Characteristics of the Participant Teachers

Variable		n	%
Gender	Female	248	65.3 %
	Male	132	34.7 %
	Total	380	100 %
Age Groups	Between 20-30	187	49.2 %
	Between 31-40	166	43.7 %
	Between 41-50	22	5.8 %
	51 and over	5	1.3 %
	Total	380	100 %
Seniority	0-5 years	118	31.1 %
	6-10 years	118	31.1 %
	11-15 years	91	23.9 %
	16-20 years	40	10.5 %
	21 years and over	13	3.4 %
	Total	380	100 %
Educational Status	Bachelor's degree	314	82.6 %
	Graduate degree	66	17.4 %
	Total	380	100 %
Faculty graduated	Faculty of Education	338	88.9 %
	Other	42	11.1 %
	Total	380	100 %

### Data Collection Instruments and Procedures

In the study, two scales were used as data collection instruments including “*Technology Literacy Scale*” developed by Yiğit (2011) and “*Proactive Personality Scale*” that was developed by Bateman and Crant (1993), revised by Claes, Beheydt and Lemmens (2005), and adapted to Turkish by Akin, Abaci, Kaya & Arici (2011).

*Technology Literacy Scale*

In the development process of the Technology Literacy Scale developed by Yigit (2011), five basic categories of Technology Literacy Standards determined by the International Technology Education Association [ITEA] (2000) were taken into account. These five main categories cover “*Abilities for a Technological World*”, “*The Nature of Technology*”, “*Technology and Society*”, “*The Designed World*” and “*Design*”. The subcategories describing these five dimensions in technology literacy are given in Table 2.

Table 2. Theoretical Structure of Technology Literacy

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The Structures of Technology Literacy
Abilities for a Technological World
- Skills to apply the design process
- Skills towards using technological products and systems and ensuring their continuity.
-Ability to assess the effectiveness of products and systems
The Nature of Technology
- Characteristics and scope of technology
- Basic concepts related to technology
- Various technologies and relations between technology and other fields of work
The Designed World
- Medical technologies
- Agricultural technology and related biotechnologies
- Energy and power technologies
- Knowledge and communication technologies
- Transportation technologies
- Production technologies
- Construction technologies
Design
- Characteristics of design
- Engineering design
-The role of repair, research and development, inventions and innovations in problem solving process
Technology and Society
- Cultural, social, economic and political effects of technology
- Effects of technology on environment
- The role of society in the development and use of technology
-Effect of technology throughout history

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The reliability of the Technology Literacy Scale was calculated as .88. The sub-dimensions of Technology Literacy Scale and their item numbers are presented in Table 3.

Table 3. The Sub-Dimensions of Technology Literacy Scale

The sub-dimensions of technology literacy scale	Item numbers
Abilities for a technological world	1-2-3-4-5-6-7-8-9-10
The nature of technology	11-12-13-14-15-16-17-18
The designed world	19-20-21-22-23-24
Design	25-26-27-28-29
Technology and society	30-31-32-33

### *Proactive Personality Scale*

Proactive Personality Scale developed by Bateman and Crant (1993) consists of 17 items and four dimensions. These dimensions are “*conscientiousness*”, “*extroversion*”, “*the needs for achievement*”, and “*the needs for dominance*”. The total reliability coefficient of the Proactive Personality Scale of Bateman and Crant (1993) was .863. The Proactive Personality Scale was revised by Claes, Beheydt and Lemmens (2005) and included 10 items. The same scale was adapted to Turkish by Akin, Abaci, Kaya and Arici (2011) and validity and reliability studies were conducted. The scale consists of one dimension and 10 items. The Cronbach Alpha internal consistency reliability coefficient of the scale adapted by Akin et al. (2011) was found as .86. The reliability of the scale (Akin et al., 2011) used in this study was calculated as .89 in this study.

### **Data Analysis**

Descriptive statistics were used to determine the technology literacy and proactive personality levels of secondary school mathematics teachers (1st and 2nd sub problems). The skewness and kurtosis coefficients of the variables were examined. The skewness and kurtosis coefficients between +1 and -1 are considered as an indicator of normality (Sencan, 2005). It was determined that the general scores of the variables ranged between .527 and .60. After analyzing the normality, descriptive statistics, Pearson product-moment correlation coefficient and simple linear regression analyses were used to analyse the data. When interpreting the values in terms of the degree of relationships, it was determined as  $.00 < r < .25$  very weak relationship,  $.26 < r < .49$  weak relationship,  $.50 < r < .69$  medium relationship,  $.70 < r < .89$  high relationship,  $.90 < r < 1.00$  very high relationship (Kalayci, 2016).

### **Results**

The data obtained from the Technology Literacy Scale and Proactive Personality Scale were analyzed by appropriate quantitative data analysis techniques to answer the sub-problems. The findings of the data analysis are given below and also presented with tables

#### **Technology Literacy Levels of Secondary School Mathematics Teachers**

The results obtained from descriptive statistical analysis techniques in order to answer the first sub-problem of

the study are given in Table 4.

Table 4. Technology Literacy Levels according to Secondary School Mathematics Teachers' Perceptions

	n	min	max	$\bar{X}$	df	Level
Technology Literacy	380	1.21	7.76	6.11	.74	High

The secondary school mathematics teachers' perceptions of technology literacy were rated with a 9-point Likert-type (extremely low, very low, low, slightly low, medium, slightly high, high, very high, extremely high) scale. Arithmetic means of the secondary school mathematics teacher perceptions were examined. The teachers' perceptions were at the 7th level among 9 levels (since the 7th level range is between 5.34-6.23, the 6.11 average is at the 7th level). The secondary school mathematics teachers' perceptions about their technology literacy were found to be high. The items in which secondary school mathematics teachers have the most positive perception on technology literacy scale are given in Table 5.

Table 5. Items with the Highest Means in Technology Literacy Scale

	n	$\bar{X}$	df	Level
39) Technological designs must be functional.	380	7.30	1.123	Extremely High
40) Defining the problem is an important element of the design process.	380	7.17	1.218	Extremely High

According to Table 5 the participant teachers' perceptions of the items expressing that “*technological designs should be functional*” and “*the stage of defining the problem in the design process is an important element*” were extremely high. According to the perceptions of secondary school mathematics teachers, the item that has the lowest level related to technology literacy was “All systems are readily available in nature” ( $\bar{X}$ =4.04,  $df$ =2.419, medium level).

### Proactive Personality Levels of Secondary School Mathematics Teachers

The results obtained from descriptive statistical analysis techniques conducted to answer the second sub-problem of the study are given in Table 6.

Table 6. Proactive Personality Levels according to Secondary School Mathematics Teachers' Perceptions

	n	Min.	Max.	$\bar{X}$	df	Level
Proactive Personality	380	1.50	8.00	6.15	1.05	High

The secondary school mathematics teachers' perceptions of their proactive personality were graded with a 9-point Likert-type (extremely low, very low, low, slightly low, medium, slightly high, high, very high, extremely high) scale. According to secondary school mathematics teachers' perceptions, the arithmetic means for their proactive personality were at the seventh level among the nine levels (level 7, 5.34-6.23). The participating mathematics teachers believe that their proactive personality is high. The items in which they have the most positive perception on proactive personality scale are given in Table 7.

Table 7. Items with the Highest Means in Proactive Personality Scale

Items	n	$\bar{X}$	Sd	Level
8) I always look for ways to do the best.	380	6.88	1.229	Very High
3) Nothing makes me more excited than making my own thoughts a reality.	380	6.53	1.462	Very High
1) I look for new ways to improve my life.	380	6.48	1.434	Very High
4) If I see something I don't like, I'll fix it.	380	6.44	1.492	Very High

According to Table 7, the secondary school mathematics teachers' perceptions of the following items were found "very high": "I always look for ways to do the best", "Nothing excites me more than making my own thoughts come true", "I look for ways to improve my own lives" and "If I see something I don't like, I'll fix it.". According to the perceptions of the secondary school mathematics teachers, the item that has the lowest level related to proactive personality is "I specialize in determining opportunities" ( $\bar{X}$ =5.27,  $df$ =1.703, slightly high).

### The Relationship between Secondary School Mathematics Teachers' Technology Literacy and Proactive Personality

In line with the third problem of the study, the relationship between the technology literacy and proactive personalities was examined according to the perceptions of the secondary school mathematics teachers, and the results of the correlation analysis were presented in Table 8.

Table 8. The Relationship between the Secondary School Mathematics Teachers' Technology Literacy and Proactive Personality

	$\bar{X}$	df	Technology Literacy	Proactive Personality
Technology Literacy	5.86	.796	1	
Proactive Personality	6.15	1.050	.554	1

As a result of the Pearson correlation analysis, there was a moderately positive correlation between technology literacy and proactive personalities according to the perceptions of secondary school mathematics teachers (Table 8;  $R=.554$ ,  $p < .05$ ). The results of the regression analysis on whether proactive personality is a significant predictor of technology literacy according to the perceptions of secondary school mathematics teachers are given in Table 9.

Table 9. The Regression Analysis between Technology Literacy and Proactive Personality of Secondary School Mathematics Teachers

Variables	B	Standard Error	B	t	P
Technology Literacy Proactive Personality	.420	.032	.554	12.936	.000

$R=.554$ ,  $R^2=.307$ ,  $p=.000$ ,  $F=167.346$

When the values in Table 9 are examined, it can be said that proactive personality is a significant predictor of technology literacy according to the perceptions of secondary school mathematics teachers ( $R=.554$ ,  $R^2=.307$ ).

Proactive personality explains 31% of technology literacy.

## **Discussion**

In this section, the results of the study are discussed with the help of the literature, and suggestions developed based on the findings are given. When we look at the results obtained, according to the perception of secondary school mathematics teachers, their technology literacy is high. Technology literacy includes all knowledge, skills and attitudes related to the use of technology (Barr & Stephenson 2011; Boschman, McKenney, & Voogt, 2015). This high level regarding technology literacy shows that secondary school mathematics teachers have high self-perceptions about having all the knowledge, skills and attitudes related to the use of technology. Agyei and Voogt (2011), Kim et al. (2013) and Teo (2010) stated that teachers who do not have a positive attitude towards technology do not use technology in their classrooms. In this study, the teachers' perceptions about considering themselves as technologically literate individuals may mean that they have a positive attitude towards technology. On the other hand, in some studies such as Carroll & Morrell (2006) and Georgina & Olson (2008), it was also stated that individuals are not able to use technology effectively although their self-perceptions regarding technology literacy is high. Boschman, McKenney, and Voogt (2015) and Jen, Yeh, Hsu, Wu, and Chen (2016) noted that teachers learn theoretically to use technology but cannot put it into practice. According to Dincer (2018), although most of the prospective teachers say that they have knowledge, skills and positive attitudes about using technology in teaching activities, some observations revealed that they have a low level of technology literacy in terms of knowledge and skills.

The result indicating that the secondary mathematics teachers have a high perception about their technology literacy should not mean that they use technology in the classroom. Mishra and Koehler (2006) highlighted that teachers should have the necessary knowledge and skills in terms of content, pedagogy and technology and that they should use these three areas interactively. Misuse of this interaction, the use of irrelevant or inappropriate technology may cause some negative effects on learning (Webb and Cox, 2004). Therefore, it is necessary to look for some answers for important problems in technology supported teaching. These questions are as follows: "What aspect of mathematics teaching and learning improves when teachers use technology??", "*Do teachers learn to teach technology?*", "*Are teachers able to use technology both as a teaching tool and a learning tool?*" (Polly & Orrill, 2012).

Future research should be conducted in order to develop environment-supported technologies by focusing on these problems. There are many studies examining the effects of using technology in mathematics teaching on learning mathematical concepts (Baki, 2002; Habre & Abboud 2006; Heid, 1995; Kidron & Tall, 2015). These studies show that technology-assisted mathematics teaching is effective in understanding mathematical concepts when technological tools are used "wisely" (Ball & Stacey, 2005). Since teaching is a complex, uncertain and non-routine task (Rowan, 2002), it may be necessary for teachers to be proactive in taking actions beyond the standard. Therefore, determining the relationship between technology and proactive behaviors of teachers can be regarded as an important issue. Bandura, who combined cognitive learning theory with behaviourist theory to construct social cognitive learning theory, was the first to introduce the concept of self-efficacy (Bandura, 1986;

Pajares, 2002). Social cognitive learning theory is based on the idea that human beings are self-regulating, self-reflecting, self-judging and proactive (foreseeing risks) (Bandura, 2001). Without a doubt, fostering mathematically literate individuals is one of the most important goals of education. For this purpose, it is noteworthy to develop affective competences (such as being proactive) as well as mathematical skills (Canturk Gunhan & Baser, 2007). This situation highlights the value of being proactive as an emotional competence.

The second result of the study is that the secondary school mathematics teachers' perceptions are high regarding their proactive personality. In the study conducted by Yucel, Kocak and Cula (2009), the teachers preferred metaphors indicating proactive personality traits for themselves, while they preferred metaphors indicating reactive personality traits for students. In other words, teachers tend to regard themselves as active, and students as passive. Proactive teachers participate in different activities as well as educational environments and they perform well beyond expectations through successful actions. Proactive people have a strong belief that they are responsible for their own development. Trying to achieve certain goals makes their lives meaningful. They believe in continuous development and therefore make great effort (Yucel, Kocak and Cula, 2009).

It was observed that the secondary school mathematics teachers considered themselves sufficient in proactive personality. However, this situation does not necessarily mean that secondary school mathematics teachers exhibit proactive personality behaviors as indicated in their self-perceptions. Teachers may have a wrong perception in this direction. According to Schwarzer (1999), many teachers have reactive (non-proactive) personalities. Seibert, Crant and Kraimer (1999), Ashford and Black (1996), Crant (2000), Morrison (1993) revealed that proactive thinking has a positive effect on job performance. After carrying out a research project with two group and 177 participants, Kirby, Kirby and Lewis (2002) reported that proactive thinking was effective on student performance and performance variables. In this respect, it can be said that the existence of proactive teachers is a positive factor in establishing effective learning environments and school culture. Yucel, Kocak and Cula (2009) marked that science-based proactive viewpoints bring a new dimension to education and training.

In addition, Kirby, Kirby and Lewis (2002) stated that proactivity is not stable over time and can be increased by education. This shows that trainings that will make the teachers proactive can be performed. In addition, Uncuoglu Yolcu and Cakmak (2017) showed that proactive personality has a positive and significant effect on proactive working behavior and that psychological empowerment has partial mediation effect between proactive personality and proactive working behavior. It is crucial for teachers to make their own decisions without waiting for orders or requests in order to demonstrate proactive working behavior. In this sense, teachers' psychological empowerment can be developed and active participation in events can be ensured. Taking initiative, taking risks, developing innovation and being in action are among the strongest entrepreneurial characteristics associated with success (Collins, 2007). The main components of entrepreneurship are considered as risk-taking, proactivity and innovation (George & Zahra, 2002; Miller, 1983; Zahra & Covin, 1995; Zhao, 2005). According to Hendron (2008), individuals with proactive personalities are able to seize opportunities in the organizational environment, perform actions related to organizational objectives and question the current situation. It is stated that proactive people are both more learning-oriented and more

determined to improve their skills and abilities than those who are not proactive in their working life.

In addition, proactive people can help their colleagues to make constructive change, share their knowledge with them, and use the resources of the organization they work for efficiently (Fuller, Marler, & Hester, 2012). For mathematics teachers, it is pivotal to be proactive and take more initiative in the process in order to realize learning differently using innovative approaches. Math teachers must constantly look for new solutions and more effective ideas, approaches and initiatives. It is rare for teachers to take initiative by breaking away from the curriculum. In the learning processes, there is a need for interdisciplinary and innovative thinking styles that education mainly aims with approaches such as STEM, mathematical modeling, gamification, and flipped classroom. The proactive personality traits of mathematics teachers are of great importance in the integration of such new approaches into the mathematics learning process. In order for the change and innovations to be carried out successfully in schools, teachers must first adopt and accept the change, be open to change and adapt the change (Lee, 2000). Based on all these results, it can be stated that mathematics teachers who have high self-efficacy perception, that is, their perception of being able to perform a job, are more open to change, and therefore they will show less resistance to changes and innovations.

The third result of the study revealed that there was a moderately significant positive relationship between the secondary school mathematics teachers' perceptions about their technology literacy and their perceptions regarding their own proactive personality. Also, it was suggested in the fourth result of the study that the secondary school mathematics teachers' perceptions about their own proactive personality explain 31% of their perceptions of their own technology literacy. In other words, the tendency of teachers having a proactive personality structure to become technologically literate individuals is at a positive and significant level. In this respect, it can be thought that the fact that teachers adopt proactive personalities in different ways will be a supportive force in their creating technology supported learning environments. Konaklioglu and Kizanikli (2011) found a positive medium-level relationship between proactive personality and entrepreneurship intention in their study with 416 university students ( $r = 0.38$ ). Considering that entrepreneurship is an important component of proactive personality, it can be said that a parallel result has been obtained. As Kyle, Kujala, Richardson, Lyytinen, & Goswami, (2013), Saine, Lerkkanen, Ahonen, Tolvanen, & Lyytinen (2011) and, Van der Kooy-Hofland (2012) stated, teachers with proactive personality can be expected to be more responsible and entrepreneurial in gaining information about technology literacy and developing their skills. This will improve teachers' technology literacy competencies and make a difference in their teaching.

In a study conducted by Li, Liu, Liu and Wang (2017) with 352 teachers, it was found that there was a significant positive correlation between proactive personalities and innovative behaviors of teachers ( $r = 0.34$ ). Considering the fact that innovative behaviors are one of the important characteristics of technologically literate people, it is seen that the study conducted by Li, Liu, Liu and Wang's (2017) study revealed results that support this study. In addition, it can be suggested that proactive individuals have a positive point of view on technology, technology innovations and technology literacy concepts, and they are more interested in gathering information about these concepts. As for the recommendations for the researchers, this study can be carried out with different groups of teachers. Apart from the teachers' own perceptions, students can be consulted, or course



observations can be performed to reveal the skills related to technology literacy. The relationship between teachers' perception of technology literacy and proactive personality, and their skills in this direction can be examined. More objective results can be presented regarding technology literacy through different data collection tools. These studies can be conducted with teachers from different cultures, and the results can be compared. This study shows a cross-sectional result. Therefore, detailed cause-effect relationships cannot be revealed. Qualitative or mixed research techniques can also be utilised in this direction.

Considering the recommendations for practitioners, the high level of perceptions of prospective teachers on technology literacy and proactive personalities have advantages and disadvantages. The disadvantage of high perception is that teachers do not feel the need to develop themselves in this direction. In addition, although mathematics teachers may have high self-perceptions about their own technology literacies and proactive personalities, their technology literacy and proactive skills may be low in practice. This is about not being aware of themselves. To ensure this awareness, courses on technology literacy should be sufficiently given in teacher education (Dincer, 2018). Kirby, Kirby and Lewis (2002) maintained that skills related to proactive personality could be increased by appropriate training. These trainings can be determined and appropriate content can be prepared and put into practice in teacher training programs.

In order to increase student achievement in mathematics, the collaboration of technology and mathematics educators is viewed as critical. For mathematics and technology teachers, appropriate environments can be created for interdisciplinary studies, and digital content that mathematics teachers can use can be developed. In the study conducted by Rasmussen and Marrongella (2006), it was revealed that the role of proactive behaviors of teachers in understanding mathematics and creating an innovative learning environment made significant contributions. Yucel, Kocak, and Cula (2010) found that the majority of pre-service mathematics teachers preferred the metaphors that teachers should be people who display proactive behaviors. Inflexible rules and procedures can prevent teachers from taking the initiative to install new procedures and methods that improve their performance (Asgari, Silong, Ahmad & Samah, 2008). In Avolio, Bass & Jung's (1985) Multi-Factor Leadership Theory, it can be said that mathematics teachers in school cultures with transformational leaders can have environments where they can reveal their proactive personalities. The relationship between Bass's (1985) multifactorial leadership types (transformational, autonomous and sustaining) that school administrators have and the proactive structures of mathematics teachers at school may be an important research subject.

## **Conclusion**

The aim of this study is to determine the secondary school mathematics teachers' perceptions about their technology literacy and proactive personality, and to examine the relationship between perceptions about their technology literacy and perceptions about their proactive personality. In this study, the relationship between proactivity and technology literacy was mentioned for the first time in the literature. In this respect, it is thought that this study will make an important contribution to the literature.

According to the study, the perceptions of secondary school mathematics teachers about their technology

literacy were found to be high. The fact that secondary mathematics teachers have a high perception about their technology literacy should not mean that they use technology in the classroom. Therefore, future studies should be conducted in order to find out secondary mathematics teachers' technology competencies. The Secondary school mathematics teachers' perceptions were high regarding their proactive personality. It was observed that the secondary school mathematics teachers considered themselves sufficient in proactive personality. However, this situation does not necessarily mean that secondary school mathematics teachers exhibit proactive personality behaviors as indicated in their self-perceptions. The teachers may have a wrong perception in this direction.

There was a moderately significant positive relationship between the secondary school mathematics teachers' perceptions about their technology literacy and their perceptions regarding their own proactive personality. Secondary school mathematics teachers' perceptions about their own proactive personality explain 31% of their perceptions of their own technology literacy. In other words, the tendency of teachers having a proactive personality structure to become technologically literate individuals is at a positive and significant level. This is the most important result of this study. In this respect, it can be thought that the fact that teachers adopt proactive personalities in different ways will be a supportive force in their creating technology supported learning environments.

This study can be carried out with different groups of teachers in the future. Apart from the teachers' own perceptions, students can be consulted, or course observations can be performed to reveal the skills related to technology literacy. More objective results can be presented regarding technology literacy through different data collection tools. These studies can be conducted with teachers from different cultures, and the results can be compared. This study shows a cross-sectional result. Therefore, detailed cause-effect relationships cannot be revealed. Qualitative or mixed research techniques can also be utilised in this direction.

The high level of perceptions of prospective teachers on technology literacy and proactive personalities has advantages and disadvantages a point of the study which is very important. The disadvantage of high perception is that teachers do not feel the need to develop themselves in this direction. In addition, although mathematics teachers may have high self-perceptions about their own technology literacies and proactive personalities, their technology literacy and proactive skills may be low in practice. This is about not being aware of themselves. Inflexible rules and procedures can prevent teachers from taking the initiative to install new procedures and methods that improve their performance. The relationship between Bass's (1985) multifactorial leadership types (transformational, autonomous and sustaining) that school administrators have and the proactive structures of mathematics teachers at school may be an important research subject.

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