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The role of perceived ICT competencies on primary school pre-service teachers' integrated STEM teaching intentions

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The purpose of this research is to determine the role of primary school pre-service teachers' perceived information and communication technology (ICT) competencies on integrated science, technology, engineering, and mathematics (STEM) teaching intentions. Research participants are 242 primary school pre-service teachers enrolled at a state university in Türkiye. The data were collected by using the "Integrative STEM Teaching Intention Questionnaire" developed by Lin and Williams (2016) and adapted into Turkish by Hacıömeroğlu and Bulut (2016), the "ICT Competence Perceptions Scale" developed by Şad and Nalçacı (2015), and the "Personal Information Form" prepared by the researchers. These data were analyzed with descriptive statistics, independent samples t-test, one-way ANOVA, linear regression analysis. The results of the research showed that primary school pre-service teachers' integrated STEM teaching intentions and perceived ICT competencies levels are above the medium. Also, integrated STEM teaching intentions and perceived ICT competencies differed significantly by gender and frequency of technology use. The research showed that male primary school pre-service teachers' integrated STEM teaching intentions and perceived ICT competencies mean scores were significantly higher than that of females. Additionally, the research revealed that primary school pre-service teachers who every time and often use technology have significantly higher integrated STEM teaching intentions and perceived ICT competencies mean scores than those who never use technology and those who rarely use it. Finally, the research revealed that perceived ICT competencies are a predictor variable that can explain 43% of integrated STEM teaching intentions. Derived implications based on the results obtained were discussed and suggestions were presented.

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Introduction

It is now generally accepted by many educators that the "separate subject" approach regarding knowledge and skills is one of the main problems in schools (Furner & Kumar, 2007). It can be said that handling the educational content in schools in a more contextual and interdisciplinary dimension will help to get rid of this main problem. Research indicates that using an integrated and interdisciplinary approach in education provides significant opportunities for meaningful experiences based on unfragmented, contextual and authentic learning (Frykholm & Glasson, 2005). A distinctive characteristic that is at the core of science, technology, engineering, and mathematics (STEM) is "integrated curriculum design" (Herschbach, 2011). The current international focus in recent committee and investigative reports has a strong emphasis on the integrated STEM education movement, where STEM disciplines are addressed in an integrated and contextual relationship without isolation from each other (Bybee, 2010; Nadelson & Seifert, 2017; National Academy of Engineering and National Research Council [NAE & NRC], 2009, 2014; NRC, 2011). The positive effects of integrated STEM teaching on different outcomes such as achievement (Dedetürk, Saylan Kırmızıgül & Kaya, 2020; Gerlach, 2020; Sarican & Akgunduz, 2018), conceptual understanding (Huri & Karpudewan, 2019), and STEM attitudes (Alnıak & Ogan Bekiroglu, 2019) support these emphases. In addition to these, technology is thought to be important in increasing the effectiveness of integrated STEM teaching. Birzina and Pigozne (2020) states that the meaningful use of technology in STEM teaching offers a way to attract learners' attention and facilitate learning STEM subjects. In this case, information and communication technology (ICT), which is thought to have a critical importance for the meaningful and comprehensive use of technology, draw attention. In this context, it can be said that the use of ICT has an important function in a successful STEM education. This situation brings us two important concepts: integrated STEM teaching and integrating ICT into education. There are undoubtedly many factors affecting these two concepts, but it is clear that the intentions and competencies of primary school teacher who will integrate them into the educational environment will be the biggest leverage point that will play a role in the integration process. Therefore, for a comprehensive and successful integrated STEM teaching, it is thought that it is important for teachers to have sufficient intention towards the use of integrated STEM teaching in the education process, and then to have competence in the use of ICT. For this, it is thought that it is an important necessity to conduct research on integrated STEM teaching intentions and perceived ICT competencies, especially in the pre-service period. In the present research, it was aimed to investigate the effect of factors thought to have an impact on integrated STEM teaching intentions and perceived ICT competencies, as well as the role on integrated STEM teaching intentions of perceived ICT competencies as a potential contextual factor. In this context, below are the theoretical framework and research questions in order to guide the research purpose.

STEM and Integrated STEM Teaching

The term STEM, which was announced by the National Science Foundation (Bybee, 2010; Koehler, Binns & Bloom, 2016), was formed as a result of the rhetorical correction of the word SMET, which is used as an abbreviation for "science, mathematics, engineering and technology" (Sanders, 2009). STEM, which is the abbreviation of science, technology, engineering, and mathematics education in current usage (Bybee, 2010; White, 2014), is not a subject or content field consisting of four separate disciplines (Jolly, 2017), but includes the investigation and integration of these four main disciplines (Wu & Anderson, 2015). In this sense, STEM education refers to a meta-discipline based on the necessity of dealing with disciplines as a whole, not separately (Ejiwale, 2013). Based on an integrated effort, this meta-discipline includes implementation processes that design solutions based on technology and innovation to complex contextual problems by removing traditional barriers among disciplines (Kennedy & Odell, 2014). In this direction, "STEM education refers to solving problems that draw on concepts and procedures from mathematics and science while incorporating the teamwork and design methodology of engineering and using appropriate technology" (Shaughnessy, 2013, p.324).

STEM education attracts a lot of attention due to both teaching quality improvement and curriculum improvement policies (NAE & NRC, 2014). With this interest, in some of the attempts for STEM education deal with one or more STEM fields separately, while in some others there have been increasing calls to emphasize the connections among STEM discipline fields (NAE & NRC, 2014). Sanders (2009), presenting a holistic approach to STEM education, introduced the concept of integrated STEM education, in which all STEM disciplines are integrated among each other. Nadelson and Seifert (2017) state that, unlike segregated STEM, which relies on knowledge and practice of a single discipline, integrated STEM refers to situations where knowledge and implementation of multiple STEM disciplines occur simultaneously within the framework of an interdisciplinary problem to achieve understanding and solution. Moore and Smith (2014) state that integrated STEM education, which combines science, technology, engineering, and mathematics disciplines within the framework of real-world problems, consists of meaningful learning experiences that involve the integration and implementation of science and mathematics, in which learners participate in engineering design on the way to technology development. Similarly, integrated STEM education can be defined "as the teaching and learning of the content and practices of disciplinary knowledge which include science and/or mathematics through the integration of the practices of engineering and engineering design of relevant technologies" (Bryan, Moore, Johnson & Roehrig, 2016, p. 23, 24).

In integrated STEM teaching, learners apply the knowledge of disciplines to a problem situation by considering them in an integrated way, instead of learning them independently. Therefore, integrated STEM teaching provides connected and meaningful learning experiences shaped around real-life problem situations. Proponents of the connected approach argue that integrated STEM structured in the context of real-world problems can increase interest, motivation, and ultimately achievement in these disciplinary fields (Pearson, 2017). Similarly, Stohlmann, Moore and Roehrig (2012) state that integrated STEM education, which makes learning more connected for learners, can increase learners' interest and performance in mathematics and science in this way.

ICT and Perceived ICT Competencies

There is a global agreement to transform education from traditional paradigms into innovative pedagogical practices (Ottestad, 2010). The collective and rigid nature of learning cannot provide an environment for innovative practices through passive and traditional methods (Aduwa-Ogiegbaen & Iyamu, 2005). For this reason, in this age where dynamism and speed are important, innovative implementations based on contemporary methods that provide the opportunity to obtain, structure and transfer knowledge quickly have to come to the fore. Technology emerges as a great guide in revealing these innovative implementations. The use and dissemination of technology, which takes place more and more in our lives, in educational practices, as in many other fields, comes to the fore (Bay, Bay & Hartman, 2021). ICT has a remarkable place in bringing technology to the fore in educational practices. ICTs constitute the basis of today's information age by causing radical changes in society (Almerich, Orellana, Suárez-Rodríguez & Díaz-García, 2016). In general, ICTs refer to the set of tools necessary to process and transmit knowledge (Kennewell, Parkinson & Tanner, 2000). Talebian, Mohammadi and Rezvanfar (2014) state that ICTs cover hardware, software, network and media related services to collect, store, process, transmit and present knowledge (voice, data, text, and images).

In a rapidly changing global competitive environment, individuals' access to information and their capacity to apply information are a necessity for basic education, and ICTs offer great hope in providing this (Aduwa-Ogiegbaen & Iyamu, 2005). In educational environments, ICTs, which have the potential to provide higher interaction in developing the intellectual and creative sides of individuals, are more effective than traditional equipment such as blackboards, textbooks, which appeal to a limited number of sensory organs of the learners (Aduwa-Ogiegbaen & Iyamu, 2005). Having dynamic and interactive content, ICTs provide various opportunities to improve learning-teaching processes, individualize teaching, and equalize the opportunities of physically separated participants, and expand the scope of existing information resources (Yusuf, 2005). Similarly, Volman and van Eck (2001) emphasize that ICTs offer various opportunities to provide learning environments that can actively deal with daily life problems through text, image, sound, animation presentations, and to enable interaction with out-of-school learning environments.

In the information and communication society we live in, the use of ICT is very important to replace and enrich education with ICT (Kanematsu & Barry, 2016). In this sense, the success in education of ICTs, which plays an important role in the analysis and transmission of rapidly collected information with striking innovations in information technology, also depends on how ICTs are included in the system (Haddad & Draxler, 2002). It can be said that one of the fields where ICTs are included in the education system is integrated STEM education. Although integrated STEM education is based on the integrated knowledge and implementation of all four disciplines, science and mathematics disciplines are generally more prominent in STEM education (Bybee, 2010; White, 2014), and technology is rarely referred to (Bybee, 2010; NAE & NRC, 2009). For this reason, it would be appropriate to examine the technology field in STEM teaching in more detail.

STEM education with an integrated approach provides an opportunity to gain experience in understanding how technologies are created with the unique implementations it provides (Hernandez, Bodin, Elliott, Ibrahim, Rambo-Hernandez, Chen & de Miranda, 2014). Through STEM, learners learn and analyze how technology is developed, how it is used and what effect it has (Jolly, 2017). Jolly (2017), who states that learners actually reveal a technology with the products-prototypes used and produced to solve a problem in STEM lessons, states that technology exists in many dimensions in STEM. In this sense, it can be said that ICTs take place in one of the dimensions where technology is integrated into STEM. ICTs have an important potential for learning and teaching STEM subjects (Hérold & Ginestié, 2017). In this sense, ICTs can be used in STEM education to describe abstract phenomena, make predictions about scientific processes, and explain scientific knowledge (Barak, 2014). Kanematsu and Barry (2016) state that ICTs are quite suitable for realizing the purpose and effectiveness of STEM education and will come to the fore more in the future. In this context, it is thought that the use of ICT, which is thought to affect STEM teaching, is important in the integrated STEM teaching process.

In the aforementioned theoretical dimension, there is a possibility that there is a relationship between the use of ICTs in education, which is one of the contents representing the technology field of STEM, and integrated STEM teaching. However, there is no clear answer about how this relationship is in the literature. Hérold and Ginestié (2017) states that there is uncertainty about which of the interactions between STEM and ICT affects which. Similarly, Chiu, Price and Ovrahim (2015) mentioned that there is limited literature on how technology, which is the main component of STEM, supports and affects STEM. In order to fill this gap and uncertainty in the literature, the technology dimension, which is a component of integrated STEM, has been tried to be emphasized through ICT in the present research. In the research, it can be said that perceived ICT competencies about integrating ICT into education may have an effective role on integrated STEM teaching intentions. The literature pointing out that competence is related to behavior or intention supports this opinion. Saracaloğlu, Yenice and Özden (2013) emphasize that in order to achieve the desired success in education, the educator must have the belief that he or she will achieve this, and state that the level of these beliefs is decided by looking at the perceived self-efficacy. Pajares (2005) states that the self-efficacy perceptions of individuals have a good effect on predicting their subsequent performance. In addition, Bandura (2006) emphasized that perceived self-efficacy is an important determinant on intentions. Therefore, one of the purposes of the research is to determine to what extent perceived ICT competencies can explain integrated STEM teaching intentions.

Depending on this purpose of the research, it is considered important to examine the factors that may affect integrated STEM teaching intentions and perceived ICT competencies. In the literature, the abundance of studies examining the effect of gender on STEM awareness (Buyruk & Korkmaz, 2016), STEM interest (Christensen & Knezek, 2017), STEM attitude (Mahoney, 2009; Ulku Kan & Murat, 2018), STEM self-efficacy (Brown, Concannon, Marx, Donaldson & Black, 2016), STEM career intentions and interests (Dabney, Tai, Almarode, Miller-Friedmann, Sonnert, Sadler & Hazari, 2012; Sadler, Sonnert, Hazari & Tai, 2012) draws attention. On the other hand, it can be said that there are relatively few studies examining the effect of gender on integrated STEM teaching intentions (Aydogan Yenmez, Gökce, Aydede & Çelik, 2021; Demir Başaran & Temircan, 2018; Günbatar & Bakırcı, 2019; Hacıömeroğlu, 2018; Karisan, Macalalag & Johnson, 2019; Şen & Timur, 2018). Therefore, more research is needed to reveal the effect of gender on integrated STEM teaching intentions. Another factor that is thought to have an impact on integrated STEM teaching intentions is thought to be related to technology. Because technology is one of the main disciplines of integrated STEM. As a result, although the technology is an important requirement in integrated STEM teaching, there has been a great shortage in the literature on the number of studies examining the effect of technology use on integrated STEM teaching. In this context, few studies have been found in the literature on the effects of technology and related factors on different fields of STEM. It has been determined that these studies investigated the effect on the interest of STEM professions of frequency of technology use (Karakaya, Avgın & Yılmaz, 2018), the effect on STEM awareness of the use of technology in science teaching (Baran, Baran, Aslan Efe & Maskan, 2020), the effect on STEM awareness the frequency of technology use (Tekerek & Karakaya, 2018), and the effect on STEM attitudes of computer ownership (Çavuş, Özgüner & Güler, 2021). Based on the existence of the mentioned studies and the fact that technology is an important component of STEM, it is thought that the frequency of technology use will have an impact on integrated STEM teaching intentions. However, in relation to technology, no study has been found that deals with the effect of the frequency of technology use on integrated STEM teaching intentions. Therefore, another purpose of the research is to focus on the effect of gender and frequency of technology use on integrated STEM teaching intentions, as factors that have not been adequately studied regarding integrated STEM teaching intentions.

Similarly, although there are studies investigating the effect of gender in different samples among the studies on the factors affecting ICT competencies in the literature (Aesaert & van Braak, 2015; Sipilä, 2014; Vitanova, Atanasova-Pachemska & Pachemska, 2014; Yusuf & Balogun, 2011), it can be said that the studies on the effect of the gender factor on the ICT competencies in the sample of pre-service teachers are quite limited. In addition, although technology is the main component of ICT, the scarcity of studies to determine the effect of the use of factors (such as computer, internet, and ICT use) related to technology on perceived ICT competencies is noteworthy. In literature, there are studies (Almerich et al., 2016; Suárez-Rodríguez, Almerich, Orellana & Díaz-García, 2018) examining the effect of computer usage frequency on ICT competencies. In addition to these, there are studies in the literature stating that those with advanced ICT competence are those who use ICT frequently (Sipilä, 2014), that there is a relationship between ICT competence and ICT use (Tondeur, Sinnaeve, van Houtte & van Braak, 2011), that experience with computers and frequency of computer use are positively related to ICT self-efficacy (Hatlevik, Throndsen, Loi & Gudmundsdottir, 2018). Accordingly, although it can be concluded that perceived ICT competence may vary by factors such as frequency of computer and ICT use, in a way, frequency of technology use, no study has been found in the literature examining the effect of the frequency of technology use on perceived ICT competencies. Therefore, the other purpose of the research is to determine on the effect of gender and frequency of technology use on perceived ICT competencies. In line with the stated purposes, answers were sought to the following research questions (RQ):

- RQ1: What is the level of pre-service primary school teachers' integrated STEM teaching intentions and perceived ICT competencies?
- RQ2: Do the pre-service primary school teachers' integrated STEM teaching intentions and perceived ICT competencies differ significantly by gender and frequency of technology use?
- RQ3: What is the role of primary school pre-service teachers' perceived ICT competencies on integrated STEM teaching intentions?

Method

Research Design

In the research, a survey design was used to determine the level of primary school pre-service teachers' integrated STEM teaching intentions and perceived ICT competencies. Survey design is quantitative research procedures in which a survey is applied to a sample to describe the attitudes, views, behaviors, or characteristics of a population (Creswell, 2015). Causal-comparative research was used to determine whether primary school pre-service teachers' integrated STEM teaching intentions and perceived ICT competencies differ by demographic characteristics. Causal-comparative research stated by Creswell (2015) as "no experimental manipulation by the research; instead, this approach involves selecting two groups that differ on some variable of interest and comparing them on one or more dependent variables" (p. 295). Correlational design was used to determine whether primary school pre-service teachers' integrated STEM teaching intentions was predicted by their perceived ICT competencies. Correlational designs are concerned with the degree of relationship between two or more quantitative variables (Fraenkel, Wallen & Hyun, 2012; Patten & Newhart, 2018). While predictions can be made based on a relationship between the variables investigated in these designs, they cannot be evaluated in the context of causality (Lodico, Spaulding & Voegtle, 2010).

Participants

Participants consist of primary school pre-service teachers enrolled in Classroom Education Program of Department of Basic Education of Faculty of Education at a state university in Türkiye. The participant group of the research was determined by the convenience sampling method (Fraenkel et al., 2012). Of the participants, 21.1% (n=51) were 1 graders, 26.9% (n=65) were 2 graders, 26.4% (n=64) were 3 graders, and 25.6% (n=62) were 4 graders. Although there is no content directly related to STEM within the scope of the courses that are thought to be related to the STEM discipline fields in the Classroom Teaching Undergraduate Program in the New Teacher Training Undergraduate Programs of the Council of Higher Education (Council of Higher Education [CoHE], 2018), it can be mentioned that there is a content that emphasizes and covers STEM indirectly with different explanations. Accordingly, 2nd, 3rd and 4th grade pre-service teachers in the research were knowledgeable about what STEM is and exemplary STEM activities suitable for primary school level, especially because of the science-based undergraduate courses (*Basic Science in Primary School, Science Laboratory Practices, Science Teaching*). The first-grade pre-service teachers in the research take *Basic Science in Primary School* course in the spring term they are studying. In the related course, pre-service teachers are informed about what STEM is and sample STEM activities suitable for primary school level. Since the data of the research in question were obtained in the middle of the spring semester, the first-grade pre-service teachers also had knowledge about STEM before data collection process. In addition to all these, before applying the data collection tools, a brief summary of information about what integrated STEM was given to the participants again. Table 1 describes the participants by their other demographic characteristics.

Table 1. Demographic characteristics of the participants

Demographic Characteristics	Groups	f	%
Gender	Female	145	59.9
	Male	97	40.1
	Total	242	100
Frequency of Technology Use	Never	15	6.2
	Rarely	33	13.6
	Often	101	41.7
	Every time	93	38.4
	Total	242	100

Data Collection Tools

Integrative STEM Teaching Intention Questionnaire

The *Integrative STEM Teaching Intention Questionnaire* determined the participants' integrated STEM teaching intentions. The Turkish adaptation of the instrument developed by Lin and Williams (2016) was made by Hacıömeroğlu and Bulut (2016). The relevant data for the validity and reliability studies of the instrument by Hacıömeroğlu and Bulut (2016) were obtained from primary school pre-service teachers. Bartlett's test of Sphericity result ($\chi^2_{(465)}$=4896,403; p<.01) and Kaiser-Meyer-Olkin (KMO) value (.93) for the instrument were determined by Hacıömeroğlu and Bulut (2016). The 7-point likert type scale consists of 31 items and 5 sub-scales (“knowledge” (4 items), “value” (6 items), “attitude” (6 items), “subjective norm” (5 items), “perceived behavioral control and behavioral intention” (10 items)). The Cronbach’s Alpha (α) internal consistency coefficient for the total scale made up of five sub-scales was calculated as α= .94, while it was α= .93 for the sub-scale of “knowledge”; α= .86 for “value”; α= .87 for “attitude”; α= .69 for “subjective norm”; α= .86 for “perceived behavioral control and behavioral intention” (Hacıömeroğlu & Bulut, 2016).

ICT Competence Perceptions Scale

The *ICT Competence Perceptions Scale* about integrating ICT into education for pre-service teachers determined the participants' perceived ICT competencies. The data required for the validity and reliability studies of this scale, which was developed by Şad and Nalçacı (2015), were obtained from pre-service teachers enrolled in different programs of the faculty of education. The scale is in 5-point likert type and consists of 30 items. Bartlett's test of Sphericity result (χ^2=5823.884; sd=435; p=0.000) and Kaiser-Meyer-Olkin (KMO) value (.96) for the scale were determined by Şad and Nalçacı (2015). Then, the scree plot and components matrix evaluation determined that the scale showed a single factor structure (Şad & Nalçacı, 2015). While the item-total correlations of the items in the scale vary between .49 and .73, Şad and Nalçacı (2015) calculated the Cronbach's Alpha coefficient as .96 and the Guttman Split-half coefficient as .94 for the scale items.

Personal Information Form

The *Personal Information Form* that includes information about the participants' gender, grade level, and frequency of technology use prepared by the researchers.

Validity and Reliability Analysis of Data Collection Tools

Confirmatory Factor Analysis (CFA) examined the goodness of fit of factor models for determining the validity of the integrated STEM teaching intention questionnaire and ICT competence perceptions scale for the present research. IBM SPSS AMOS Version 21 program performed CFA of the data. Table 2 report the fit indices for the measurement models.

Table 2. Fit indices about CFA model

Indices	Measure Statistics for Integrated STEM Teaching Intentions	Statistics for ICT Competence Perceptions
χ^2	497.527	478.580
df	421	399
χ^2/df	1.182	1.199
RMSEA	.027	.029
SRMR	.040	.052
NFI	.90	.92
CFI	.98	.99
GFI	.89	.90
AGFI	.87	.87

Note. χ^2= Chi-Square; df= Degree of freedom; RMSEA= Root Mean Square Error of Approximation; SRMR= (Standardized) Root Mean Square Residual; NFI= Normed Fit Index; CFI= Comparative Fit Index; GFI= Goodness of Fit Index; AGFI= Adjusted Goodness of Fit Index

Table 2 revealed the model fit indices for the integrated STEM teaching intentions and ICT competence perceptions measurements in this research. For the integrated STEM teaching intentions measure, the model fit indexes are: χ^2/df= 1.182, RMSEA= .027, SRMR= .040, NFI= .90, CFI= .98, GFI= .89, AGFI=.87. For the ICT competence perceptions measure, the model fit indexes are: χ^2/df= 1.199, RMSEA= .029, SRMR= .052, NFI= .92, CFI= .99, GFI= .90, AGFI= .87. A ratio of less than 2 for χ2/df is a fairly good fit for the model (Cohen, 1996). In providing an adequate fit for the RMSEA value, a value of .05 or less indicates close fit (Browne & Cudeck, 1992; Schumacker & Lomax, 2004), a cut-off value of .06 or less indicates a good fit (Hu & Bentler, 1999), and a value less than .08 indicates an acceptable fit (Hu & Bentler, 1999; Stevens, 2009). According to Schumacker and Lomax (2004), SRMR< .05 is a sufficient indicator for compliance; for some researchers (Hu & Bentler, 1999; Stevens, 2009), values of .8 and lower for SRMR generally indicate a good fit. Values greater than .9 for the GFI are usually associated with suitable models (Cole, 1987; Stevens, 2009), while values greater than .9 for NFI are an adequate fit (Byrne, 1995; Stevens, 2009), values greater than .9 for CFI indicate an acceptable fit to the data (Byrne, 1995). Cole (1987) noted that an AGFI greater than .8 generally indicates a good fit. All these good fit index values point to a suitable model. Thus, the CFA results (Table 2) confirmed that the model fit was acceptable between the measurement models and the observed data.

Internal consistency coefficient Cronbach's Alpha (α) tested the reliability of data collection tools for this research. Cronbach's Alpha for the integrated STEM teaching intentions total scale made up of five factors was calculated as α = .94, while it was α = .94 for the factor of "knowledge"; α =.86 for "value"; α = .80 for "attitude"; α = .89 for "subjective norm"; α = .94 for "perceived behavioral control and behavioral intention". Cronbach's Alpha was calculated for the ICT competence perceptions total scale as .9. Cronbach's Alpha value is considered as acceptable for over .70, good for over .8, and excellent for over .9 (George & Mallery, 2020). As a result, it can be said that data collection tools are valid and reliable.

Data Analysis

Data were analyzed with IBM SPSS Statistics 23. A value of. 05 was taken as a reference for the level of significance in the analysis of the data. Analysis was performed by using arithmetic mean, standard deviation, frequency, percentage value, one-way ANOVA, independent samples t-test, linear regression analysis. Frequency and percentage calculations revealed the distribution by participants' demographic characteristics. The arithmetic mean and standard deviation values were used to reveal participants' integrated STEM teaching intentions and perceived ICT competencies level.

One-way ANOVA is used to determine the difference between the means of three or more independent (unrelated) groups and whether this difference is significant (Abu-Bader, 2021, Aldrich & Cunningham, 2016; Ho, 2018). In the research, one-way ANOVA determined whether participants' integrated STEM teaching intentions and perceived ICT competencies mean scores are significantly different by frequency of technology use and the significance of this difference. Homogeneity of variances and normality, which are the necessary assumptions to use one-way ANOVA (Abbott, 2017; Abu-Bader, 2021) were checked before the analysis. Normality can be evaluated by obtaining skewness and kurtosis values (Pallant, 2001). Skewness and kurtosis coefficient values between -2 and +2 are as acceptable level (George & Mallery, 2020). In the research, skewness and kurtosis coefficient values for integrated STEM teaching intentions (Skewness= -.658, Kurtosis= -.478) and perceived ICT competencies (Skewness= -.476, Kurtosis= 1.025) revealed the suitability of the data for normal distribution. For homogeneity of variances, it is expected to obtain a significance level greater than .05 in Levene's test (Pallant, 2001). In data analysis, Levene’s test results for integrated STEM teaching intentions mean scores (p= .678, p>.05) and perceived ICT competencies mean scores (p= .056, p>.05) showed no significant difference between the variances. When a significant F value is given in one-way ANOVA, post hoc tests can be performed to determine from which groups the significant difference originates (Pallant, 2001); the most flexible and popular of these is the Scheffé test (Ho, 2018). Scheffé test was used to determine which group the difference originated from for the mean scores of integrated STEM teaching intentions and perceived ICT competencies that differed significantly by the frequency of technology use.

Independent samples t-test provides statistical evidence of whether the two-sample mean is significantly different (Abbott, 2017; Aldrich & Cunningham, 2016). Independent samples t-test revealed whether participants’ integrated STEM teaching intentions and perceived ICT competencies differed significantly by gender. The assumptions including homogeneity of variances and normality and required to use the independent samples t-test (Cronk, 2020) were checked before the analysis. The skewness and kurtosis coefficient values for the integrated STEM teaching intentions and perceived ICT competencies obtained in the research revealed the suitability of the data for the normal distribution. Levene’s test results for integrated STEM teaching intentions mean scores (p= .217, p>.05) and perceived ICT competencies mean scores (p= .600, p>.05) showed no significant difference between the variances.

Simple regression is able to predict the most probable value for another variable when a value is entered for one variable (George & Mallery, 2020). The suitability of all assumptions including linearity, homoscedasticity, normality of error, sample size, outliers, and influential cases for linear regression analysis (Abu-Bader, 2021) was checked before the analysis. In the research, linear regression analysis was used to determine to what extent participants' perceived ICT competencies predicted their integrated STEM teaching intentions.

Results

Mean scores of the scales and sub-dimensions used in the research determined the level of primary school pre-service teachers’ integrated STEM teaching intentions and perceived ICT competencies. Table 3 shows a general level of primary school pre-service teachers’ integrated STEM teaching intentions and perceived ICT competencies levels.

Table 3. Descriptive statistics for integrated STEM teaching intentions and perceived ICT competencies level

Variables	n	M	SD
Knowledge	242	3.64	1.32
Value	242	4.49	1.08
Attitude	242	5.00	.82
Subjective Norm	242	4.41	1.10
Perceived Behavioral Control and Behavioral Intention	242	5.01	.93
Integrated STEM Teaching Intentions	242	4.63	.75
Perceived ICT Competencies	242	3.30	.60

M=Mean; SD= Standard Deviation

Table 3 revealed that primary school pre-service teachers’ integrated STEM teaching intention mean score (M=4.63) is above the medium level, but not very close to 7, which is the highest level that can be reached. It shows that primary school pre-service teachers’ integrated STEM teaching intentions in the "perceived behavioral control and behavioral intention" sub-dimension have the highest mean score (M=5.01), while the integrated STEM teaching intentions in the "knowledge" sub-dimension have the lowest mean score (M=3.64). In addition, Table 3 showed that primary school pre-service teachers' perceived ICT competencies mean score (M=3.30) is above the medium level. Table 4 present independent samples t-test statistics results to determine whether primary school pre-service teachers' integrated STEM teaching intentions and perceived ICT competencies differ significantly by gender.

Table 4. Independent samples t-test statistics results by gender

Variables	Gender	n	M	SD	df	t	p
Integrated STEM Teaching Intentions	Female	145	4.43	.70	240	5.442	.000*
	Male	97	4.94	.73			
Perceived ICT Competencies	Female	145	3.19	.59	240	3.720	.000*
	Male	97	3.47	.58			

*p<.05; M= Mean; SD=Standard Deviation

In Table 4, the research reveal a significant difference in integrated STEM teaching intentions by gender ($t_{(240)}$=5.442, p<.05). It showed that male primary school pre-service teachers' integrated STEM teaching intention mean score (M=4.94) was significantly higher than females (M=4.43). In addition, Table 4 reveal a significant difference in perceived ICT competencies by gender ($t_{(240)}$=3.720, p<.05). It showed that male primary school pre-service teachers' perceived ICT competencies mean score (M=3.47) was significantly higher than females (M=3.19). Table 5 shows one-way ANOVA statistics results to determine whether primary school pre-service teachers' integrated STEM teaching intentions and perceived ICT competencies differ significantly by frequency of technology use.

Table 5. One-way ANOVA statistics results by frequency of technology use

Variables	Frequency of Technology Use	n	M	SD	Source of Variance	Sum of Squares	df	Mean Square	F	p	Difference
Integrated STEM Teaching Intentions	Never	15	3.42	.40	Between Groups	59.147	3	19.716	60.964	.000*	1-3, 1-4, 2-3, 2-4
	Rarely	33	3.78	.50	Within Groups	76.969	238	.323			
	Often	101	4.77	.57	Total	136.117	241				
	Every time	93	4.98	.61							
	Total	242	4.63	.75							
Perceived ICT Competencies	Never	15	2.63	.43	Between Groups	15.056	3	5.019	16.639	.000*	1-3, 1-4, 2-3, 2-4
	Rarely	33	2.90	.44	Within Groups	71.783	238	.302			
	Often	101	3.40	.49	Total	86.839	241				
	Every time	93	3.44	.65							
	Total	242	3.30	.60							

*p<.05; M=Mean; SD=Standard Deviation; Difference: 1=Never; 2= Rarely; 3=Often; 4=Every time

In the Table 5, the research revealed that integrated STEM teaching intentions and perceived ICT competencies mean scores were respectively ($M_{\text{integrated STEM teaching intentions}}$=4.98; $M_{\text{perceived ICT competencies}}$=3.44) for those who every time use technology, ($M_{\text{integrated STEM teaching intentions}}$=4.77; $M_{\text{perceived ICT competencies}}$=3.40) for those who often use technology, ($M_{\text{integrated STEM teaching intentions}}$=3.78; $M_{\text{perceived ICT competencies}}$=2.90) for those who rarely use technology, and ($M_{\text{integrated STEM teaching intentions}}$=3.42; $M_{\text{perceived ICT competencies}}$=2.63) for those who never use technology. Table 5 show primary school pre-service teachers' integrated STEM teaching intentions [$F_{(3\text{-}238)}$= 60.964, p< .05] and perceived ICT competencies [$F_{(3\text{-}238)}$= 16.639, p< .05] differ significantly by the frequency of technology use. Scheffé test was used to determine which groups caused the significant difference. Scheffé test show that integrated STEM teaching intention mean score of primary school pre-service teachers who use technology every time (M= 4.98) and often (M= 4.77) is higher than those who never use technology (M= 3.42) and rarely use it (M= 3.78). When primary school pre-service teachers' perceived ICT competencies are evaluated by the frequency of technology use, Scheffé test show that perceived ICT competencies mean score of primary school pre-service teachers who use technology every time (M= 3.44) and often (M= 3.40) is higher than those who never use technology (M= 2.63) and rarely use it (M= 2.90). Table 6 present linear regression analysis results to determine whether perceived ICT competencies predict integrated STEM teaching intentions.

Table 6. Linear regression analysis results

Variable	B	SEB	β	t	p
Constant	1.935	.206	-	9.411	.000*
Perceived ICT Competencies	.817	.061	.652	13.336	.000*

Dependent Variable: Integrated STEM Teaching Intentions
$F_{(1\text{-}240)}$= 177.840, p= .000*
R= .652, R^2= .426

*p<.05; n=242

In the Table 6, in a meaningful regression model ($F_{(1\text{-}240)}$= 177.840, p<.05), perceived ICT competencies variable and integrated STEM teaching intentions variable exhibit a moderate and significant relationship (R= 652, R^2= .426, p <.05), and perceived ICT competencies explains 43% of the total variance. In other words, the 43% change in integrated STEM teaching intentions is explained by the perceived ICT competencies included in the model. The t-test results related to significance of the regression coefficients showed that perceived ICT competencies predicted integrated STEM teaching intentions significantly and positively.

Discussion and Conclusion

This research examined the levels of primary school pre-service teachers' integrated STEM teaching intentions and perceived ICT competencies, whether they differed by demographic variables, and the role of perceived ICT competencies on integrated STEM teaching intentions. The present research has contributed to the literature by addressing gender and frequency of technology use as factors, which are thought to affect integrated STEM teaching intentions and perceived ICT competencies. Further research into other factors thought to have an effect could help identify factors that will motivate to increase integrated STEM teaching intentions and perceived ICT competencies.

The present research revealed that primary school pre-service teachers' integrated STEM teaching intentions level (M= 4.63) was above medium. This result shows that primary school pre-service teachers may have a positive intention towards integrating STEM into the teaching process in the future. The literature presents similar research results. Hacıömeroğlu (2018) determined that primary school pre-service teachers have a positive intention to adapt and use integrated STEM teaching. Şen and Timur (2018) reported that primary school pre-service teachers' integrated STEM teaching intentions are above medium (M=5.33), that is, positive. Although these studies in the literature were carried out with samples similar to the present research, these studies reached higher averages for intentions. This result in these studies can be explained by the differences in the number of samples studied and other factors that may influence intentions. The present research showed that primary school pre-service teachers' integrated STEM teaching intentions were above-medium level in the sub-dimensions of “knowledge” (M=3.64), “subjective norm” (M=4.41), “value” (M=4.49), “attitude” (M=5.00), “perceived behavioral control and behavioral intention” (M=5.01). There is similar research result in the literature. Hacıömeroğlu (2018) reported that primary school pre-service teachers' integrated STEM teaching intentions were above-medium level in the sub-dimensions of “knowledge”, “value”, “subjective norm”, “attitude”, “perceived behavioral control and behavioral intention”. The “knowledge” sub-dimension includes having knowledge about the related STEM discipline and integrating this knowledge in other STEM disciplines (Lin & Williams, 2016). In this context, as a result of present research, it can be said that primary school pre-service teachers have towards positive intention to have knowledge about STEM disciplines and to integrate knowledge of a discipline with other STEM disciplines. The “subjective norm” sub-dimension refers to the individual's impressions of the support or opposition of significant reference groups (school administrators, education authorities, other teachers, parents) to the implementation of STEM teaching, and the individual's reaction to these norms (Lin & Williams, 2016). Accordingly, the research revealed that primary school pre-service teachers may have a positive intention towards the decisions of important reference groups and in their own reactions to these decisions. The “value” sub-dimension expresses individual's changes in criteria related to STEM teaching and how these changes affect the individual's self and learners' evaluations of their own practices (Lin & Williams, 2016). The fact that the value dimension intentions are toward positive indicates that the changes in the views of primary school pre-service teachers about their own criteria in STEM teaching may have a positive intention to affect their self-evaluation and learners' evaluations regarding STEM practices. The “attitude” sub-dimension expresses individuals' interest in STEM teaching and the possibility of applying and discussing STEM-related issues (Lin & Williams, 2016). The fact that the research revealed positive opinions in the attitude sub-dimension can be evaluated as the primary school pre-service teachers' interest in STEM teaching and their intention to discuss and practice STEM-related issues may be positive. The “perceived behavioral control and behavioral intention” sub-dimension refers to the problems that pre-service teachers encounter when they decide to implement STEM teaching, and their probability of successfully solving the difficulties by checking the appropriate resources while solving these problems (Lin & Williams, 2016). As a result of the research showing positive opinions in the mentioned sub-dimension, it can be said that primary school pre-service teachers have a positive intention regarding their awareness of the problems they encounter while applying STEM teaching and the possibility of successfully solving these problems by using appropriate resources. Even if it is towards the positive in the sub-dimensions of integrated STEM teaching, the lowest intention is in the “knowledge” sub-dimension. This may be due to the fact that primary school pre-service teachers do not have enough knowledge about STEM and integrated STEM. To achieve more positive results in “knowledge” sub-dimension of integrated STEM teaching intention and, as a result, integrated STEM teaching intentions, it seems necessary to make some arrangements in teacher training programs and undergraduate courses. It is clear that the courses (*Basic Science in Primary School, Science Laboratory Practices, Basic Mathematic in Primary School, Mathematic Teaching I and II, Science Teaching, Environmental Education, Information Technologies, Instructional Technologies*) that can be related to the STEM discipline fields in Classroom Teaching Undergraduate Program in the New Teacher Training Undergraduate Programs of the Council of Higher Education (CoHE, 2018) are quite limited and there is no significant emphasis on STEM education in the content of these courses. This situation can be considered as an important obstacle for the participants in this research to have a sufficiently positive integrated STEM teaching intentions. In order to improve the current situation, STEM and STEM activities can be integrated into the content of all courses related to STEM disciplines in existing undergraduate programs. In addition, arrangements can be made in the teacher training program to enable pre-service teachers to perform more STEM activities during their internship periods.

The research revealed that primary school pre-service teachers' integrated STEM teaching intentions differed significantly by gender. The research showed that male primary school pre-service teachers had a significantly more positive integrated STEM teaching intentions compared to females. Studies on this subject have revealed results contrary to this research and the literature. Günbatar and Bakırcı (2019) suggested that pre-service teachers' integrated STEM teaching intentions did not differ significantly by gender, which may be due to the fact that pre-service teachers took the same courses. Aydogan Yenmez et al. (2021) and Karisan et al. (2019) found that there was no significant difference among pre-service teachers' integrated STEM teaching intentions by gender. Although Lin and Williams (2016) revealed that S&T pre-service teachers' gender did not have a significant effect on STEM teaching intentions, they emphasized the existence of literature that did not support their findings. Contrary to these studies results, the literature provides bases to support the present research findings. In the present research, the significantly gender difference in integrated STEM teaching intentions can be attributed to the gender gap/inequality in STEM or to the fact that some factors related to STEM disciplines may differ in terms of gender. The existence of the literature provides the scientific basis that can explain the possible reasons for the findings of the present research by revealing the context related to the source of gender differences in STEM. In addition to studies that reveal gender discrepancies related to STEM, which is an important element in the academic and social context (Reinking & Martin, 2018), explanations for gender inequality in STEM fields have been discussed for years (Hayes & Bigler, 2013). In parallel, among the different stereotypes regarding scientists, mathematicians, engineers and STEM careers, the phenomenon of “maleness” seems to be an important and recurrent component (Piatek-Jimenez, Cribbs & Gill, 2018). Reinking and Martin (2018) mentions the existence of a well-known phenomenon related to STEM that advances male and ignores female. In this context, it can be mentioned that there exists a growing emphasis in the literature covering STEM-related research, in which males are dominant and thusly come to the fore. Studies on the factors causing to the lack of gender diversity in STEM and women's underrepresentation in STEM has increased dramatically in recent years (O’Brien, Blodorn, Adams, Garcia & Hammer, 2015; Saucerman & Vasquez, 2014; Soylu Yalcinkaya & Adams, 2020; Watt, Richardson & Devos, 2013). Ceci, Williams and Barnett (2009) stated that many academics expressed their views on the women's underrepresentation in STEM fields. Also, there are many researchers who emphasize the women's underrepresentation in STEM fields (Blickenstaff, 2005; Nimmesgern, 2016). On the other hand, Kanny, Sax and Riggers-Piehl (2014) put forward 5 main explanations as determinants of gender difference in STEM: “individual background characteristics”; “structural barriers in K−12 education”; “psychological factors, values and preferences”; “family influences and expectations” and “perceptions of STEM fields”. It has been determined that an important literature on the women's underrepresentation and gender differences in the STEM consists of traditional/stereotypical ideas about women's roles in society and the workplace (Carnevale, Smith & Melton, 2011), “masculine cultures”, “insufficient early experience”, and “gender gaps in self-efficacy” (Cheryan, Ziegler, Montoya & Jiang, 2017, p.21), gender difference in interest in science and mathematics (Xie, Fang & Shauman, 2015). The reasons for the women's underrepresentation in STEM in this presented literature may have also been influential as a result of the present research.

According to the relevant literature, the development of factors related to the women's underrepresentation in STEM may be based on a long-term history. In this case, in order to basically minimize these factors, which are thought to have an impact, some changes and arrangements should be made starting from the distant past, not the recent past. In this direction, precautions should be taken to eliminate gender inequality from an early period both in societies where the masculine cultural structure is dominant and in the education process. Blickenstaff (2005) emphasizes the importance of improving existing classroom teaching, pointing out the need to focus on improving science education beyond focusing on women to minimize the women's underrepresentation in STEM. In this sense, in the current pre-service education, considering the importance of STEM and related discipline fields in science education, it can be suggested to make an arrangement in which STEM fields will be included in a wider scope at almost every level of the instructional curriculum in teacher training programs. Ensuring that pre-service teachers take equal participation and responsibility in the courses related to science education and STEM discipline, regardless of gender, and helping female candidates to experience by doing and living and gain self-confidence can help reduce gender differences in integrated STEM teaching intention.

It is clear that technology is one of the core discipline fields of integrated STEM. Accordingly, it can be accepted as an expected result that many factors related to technology and its use interact with integrated STEM teaching and STEM practices. Ayvacı, Alaca and Er Nas (2020) obtained findings that teachers felt inadequate about the use of technology at the stage of applicability of Science and Engineering applications in science courses. On the other hand, Değirmenci (2020) determined that there is a moderately positive significant relationship between the self-efficacy of technology use in education and STEM implementations self-efficacy of teachers with STEM education. These results indicate that there may be a link between technology use and STEM teaching/practices. Therefore, determining the effect of technology use among the factors that may affect pre-service teachers' integrated STEM teaching intentions will be a guide for improving integrated STEM teaching and STEM practices in the future. Therefore, the present research examined the effect of the frequency of technology use on integrated STEM teaching intentions. There is no study in the literature that examines the effect on integrated STEM teaching intentions of the frequency of technology use. Therefore, it can be said that the result of this research will contribute to the literature in determining the factors affecting integrated STEM teaching intentions. The research revealed that primary school pre-service teachers' integrated STEM teaching intentions differed significantly by frequency of technology use. Accordingly, it can be said that those who every time and often use technology have more positive intentions to integrated STEM teaching than those who never use technology and those who rarely use it. The results of studies in different samples in the literature that deal with the effect of technology on different dimensions of STEM indirectly support the present research results. Güngör (2021), stating that the use of technology is effective in the formation of integrated STEM education self-efficacy of pre-service teachers, reported that pre-service teachers with a high interest in technology also have high integrated STEM knowledge self-efficacy. Thibaut, Knipprath, Dehaene and Depaepe (2018) reported that experience in technology teaching was positively correlated with attitudes towards STEM integration. Karakaya et al. (2018) reported that the frequency of technology use causes a significant difference in the level of interest in STEM professions (interest in technology professions). Contrary to these studies, there are also studies in the literature stating that pre-service teachers' STEM awareness does not differ by the frequency of technology use (Tekerek & Karakaya, 2018), and that pre-service teachers' attitudes towards STEM education do not differ significantly by computer ownership (Çavuş et al., 2021). In the light of the present research and the research results supporting it, it can be said that presenting the environment and content to pre-service teachers where they can interact with technology more closely and increasing the time they spend with technology in a qualified way will affect their positive integrated STEM teaching intentions. For this, there will be steps to be taken to increase the frequency of educational use of technology, especially in teaching environments, beyond the individual use of technology. For this purpose, it can be suggested that the courses in teacher training programs should be integrated with technology as much as possible in the pre-service period. Also, it can be ensured that pre-service teachers should be encouraged to make implementations by making more use of technology during undergraduate courses and internship periods.

The present research revealed that primary school pre-service teachers' perceived ICT competencies were at the level of 3.30. Therefore, it can be said that primary school pre-service teachers consider themselves to be slightly above average adequate in terms of integrating ICT into education. The result of the present research is close to the studies in the literature that reveal that undergraduate students regarding ICT competencies perceptions perceive themselves as adequate level (Akgün, 2020; Şad & Nalçacı, 2015) and high adequate level (Gastelú, Kiss & Domínguez, 2015). Chen, Lim and Tan (2010) determined that pre-service teachers' perceived ICT competencies for teaching were lower than their everyday ICT competence. Chen et al. (2010) pointed out that pre-service teachers heavily adopt ICT-related technologies for non-educational purposes, which may be due to their lack of expertise to decide how best to use ICT for educational purposes. Similarly, in the present research, the fact that primary school pre-service teachers did not have sufficient knowledge, skills and practical experience about integrating ICT into education may have encouraged an obstacle for their perceived competence levels to be higher. Bingimlas (2009) states that the teacher training process, in which modern technology is integrated, helps to increase the teachers' effectiveness of using ICT in education effectively. Based on this, primary school pre-service teachers should be trained within the framework of a technology-integrated teacher training program so that they can integrate ICT into their classrooms in the future. In order to improve pre-service teachers' perceived competencies regarding the use of ICT in education, beyond daily use, the use of ICT for educational purposes can be increased, especially in the learning processes in the pre-service period. For this reason, pre-service teacher can be helped to adopt the use of ICT and develop their competence to integrate ICT into education by providing practical experience within the scope of the classroom climate and curriculum in which technology is integrated. Tondeur, Pareja Roblin, van Braak, Voogt and Prestridge (2017) pointed out that the link between what teachers learn in their pre-service teacher training and what they need to improve in the use of technology in the classroom is weak; emphasized the importance of establishing a connection between technology, pedagogy and content knowledge in theoretical and applied courses in the teacher training process. For this reason, in the pre-service period, especially primary school pre-service teachers should be provided with the opportunity to use ICT in learning environments where ICT is integrated into education, and it should be ensured that they get to know ICT. Thus, it can be ensured that primary school pre-service teachers get to know ICT in the context of their pedagogical lessons, thus making connections among theory, practice, and pedagogy.

The research revealed that primary school pre-service teachers' perceived ICT competencies differed significantly by gender. Accordingly, it can be said that male primary school pre-service teachers have higher perceived ICT competencies about integrating ICT into education compared to females. This result is in line with some previous studies stating that gender has a significant effect on perceived ICT competencies. Studies by Goktas, Yildirim and Yildirim (2009) and Tobishima (2020) also revealed that gender had a significant effect on perceived ICT competencies, with male having a higher average than female. Hew and Leong (2011) found that ICT competencies (presentation, spreadsheet, world wide web, email, database, social networking, pc maintenance, utility) among pre-university students were higher in men than in women, and this difference in pc maintenance competence was significantly in favor of men. Valasidou & Bousiou-Makridou (2008) reported that male students were more likely to use ICT in their study with undergraduate students and they used ICT more frequently than women. Madigan, Goodfellow and Stone (2007) revealed that although female undergraduates have similar ICT skills as males, they have less self-confidence and do not perceive as competence themselves in some of the ICT skill fields (basic computing domain and internet domain (downloading files and adding bookmarks)). In her study that analyzed undergraduate students' differences in self-reported IT skills and attitudes over 3 years (1998-1999, 1999–2000 and 2000–2001), Lee (2003) revealed that a large proportion of females compared to males rated themselves as less proficient in IT skills, less confident in their IT attitudes, and less familiar with software packages. On the other hand, the present research result is different from some other studies that stated that gender did not have a significant effect on perceived ICT competencies. Amini and Oluyide (2020) found that gender did not have a significant effect on undergraduate students' ICT competencies. Taşpolat (2016) found that there was no significant gender difference among perceived ICT competencies of pre-service teachers. Tondeur, Aesaert, Prestridge and Consuegra (2018) revealed that the pre-service teachers' gender did not affect ICT competencies for educational practices. The existence of studies that found that gender did not have a significant effect on perceived ICT competencies, but that male had higher perceived ICT competencies than female, draws attention to a difference in ICT competencies in favor of male. Danner and Pessu (2013) reported that pre-service teachers' gender did not have a significant effect on perceived ICT competencies scores, but males' perceived ICT competencies scores were higher than those of females. In the studies of Sezen-Gultekin, Hamutoglu and Topal (2021) and Gündüz (2020), it was determined that male pre-service teachers had a higher ICT competence than female, but this difference was not significant. In line with the present research result revealing the significant effect of gender on perceived ICT competencies about integrating ICT into education, these gender differences during integrating ICT into education in the future can be considered as a potential that can create an obstacle to the provision of equal and similar behavior in the context of gender. Minimizing the negative differences that may arise from basic personal qualities such as gender that may affect the educational process and practices will pave the way for each learner to receive a higher quality education by being minimally affected by the conditions that may arise from these differences. In the light of present research results, it is recommended to empirically investigate the effect of pre-service teachers' gender on their ICT competencies about integrating ICT into education. In this way, necessary practices or some innovations in the instructional curriculum can be made in the pre-service period in order to reduce the gender-based differences among primary school pre-service teachers' ICT competencies about integrating ICT into education. Thus, by reducing the lack of competence that may arise from gender in the future, the possibility of each learner to encounter incomplete or insufficient educational processes due to the gender of the trainer can be minimized.

The research revealed that primary school pre-service teachers' perceived ICT competencies differed significantly by frequency of technology use. It can be said that those who use technology every time and often, compared to those who never use technology and those who rarely use it, perceive themselves to be significantly more competent about integrating ICT into education. At the same time, the results revealed that primary school pre-service teachers who use technology more frequently have higher perceived ICT competencies about integrating ICT into education. In the ICT integration process in education, which expresses a process that is largely related to computer-based communication, use of instructional technologies, technology-based learning and teaching in the education process (Ghavifekr & Rosdy, 2015), it is important to be interaction with technology. In this context, it can be considered as an expected result that frequency of technology use will have an impact on perceived ICT competencies. The literature supports this result of the present research. Emphasizing that those who use technology more frequently will integrate technology into education better, Hosein, Ramanau and Jones (2010) revealed that the frequency of ICT use for social and leisure purposes, and study purposes is related to undergraduate students' perceived competencies regarding ICT use. Buabeng-Andoh and Issifu (2015) revealed that learners' access to computers in the learning process is significantly related to the pedagogical use of ICT and is an important predictor of it. Hammond, Reynolds and Ingram (2011) reported that pre-service teachers who felt the least self-efficacy regarding the use of ICT were among those who used ICT the least frequently. Pullen (2015) stated that high level or frequent use of ICT tools has a positive effect on ICT competence and reported that learners with more experience in ICT stated that they were more competence in using ICT. Al-Zaidiyeen, Mei and Fook (2010) determined that the level of technology use has a direct relationship with the use of ICT for educational purposes, and there is a significant positive relationship between them. Goktas and Demirel (2012) concluded that pre-service teachers' use of blogs, which is perceived as an ICT tool, has a positive effect on their ICT perceptions and may influence their acquisition of ICT competencies. Haznedar (2012), in her study with undergraduate students, reported that ICT skills differed significantly in favor of those with higher computer experience and higher frequency of internet use. In the present research, technology use of pre-service teachers was discussed in general terms. Examining the frequency of use by considering technology usage purposes (e.g., for individual purposes, educational purposes) and technology types in future studies will help to reveal more detailed results on ICT competencies. However, based on the results of the present research, it is thought that the increase in the frequency and duration of technology use of primary school teacher candidates will contribute positively to their perceived ICT competencies about integrating ICT into education in their classrooms in the future. There are studies in the literature that can support this opinion. Vitanova et al. (2014) reported that the experience of working with computers (years of computer usage) is a factor that positively affects the increase of primary school teachers' ICT competence and the frequency of ICT use in teaching. Similarly, Tezci (2010) in his study with primary school teachers reported that the computer and internet use' duration showed a positive and significant relationship with the frequency of ICT use in education and ICT knowledge levels. At the same time, Tezci (2010) pointed out that as the computer and internet use' duration increases, so do experiences and attitudes towards ICT.

Considering that technology is one of the basic disciplines of integrated STEM, the use of technology in integrated STEM teaching is inevitable. Having an intention towards performing integrated STEM teaching also requires mastering the factors that must be used in the integrated STEM teaching process. Since technology is one of the basic disciplines of integrated STEM, it seems necessary to have a certain competence in using technology in order to have an integrated STEM teaching intention. In this context, in the present research, it is thought that technology use competence comes first among the factors that will affect pre-service teachers' integrated STEM teaching intentions. Therefore, in this research, technology was considered as ICT in a more specific context, and the effect of perceived ICT competencies on integrated STEM teaching intentions was tried to be determined. However, in the literature, no study has been found that addresses the role of perceived ICT competencies on integrated STEM teaching intention. The fact that technology is rarely referred to in integrated STEM (Bybee, 2010), so other disciplines are at the forefront, may have drawn a limit in considering factors such as technology or the use of ICT that may be related to it in studies on this subject. In this sense, it is hoped that the present research will contribute to the literature with this finding. Accordingly, the research contributed to the explanation of integrated STEM teaching intention by considering perceived ICT competencies as predictive factor. Perceived ICT competencies in the research reveal 43% of the variance in integrated STEM teaching intentions. In this case, it can be said that perceived ICT competencies have a 43% role among the factors affecting integrated STEM teaching intentions. At this point, this research reported that primary school pre-service teachers' perceived ICT competencies about integrating ICT into education may be an important factor on their integrated STEM teaching intentions. Although this is an expected result, no study has been found in the literature on the factors predicting integrated STEM teaching intentions. For future studies, it may be suggested to investigate this research subject in larger and different samples. In addition, it is recommended to conduct experimental studies in order to evaluate the present research result in the context of causality.

Ethics Statement

The research was approved by Van Yüzüncü Yıl University Social and Human Sciences Publication Ethics Committee decision number 2022/04-05 dated 08.02.2022.

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