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The relationship between technological pedagogical content knowledge (TPACK) self-efficacy belief levels and the usage of Web 2.0 applications of pre-service science teachers

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Abstract

The purpose of this study is to determine the technological pedagogical content knowledge (TPACK) self-efficacy levels of pre-service science teachers with respect to variables in their use of Web 2.0 applications. A survey model has been conducted on a study group consisting of 344 final year pre-service science teachers at six different state universities in Turkey during the academic year of 2017–2018. The 'personal information form', the 'Web 2.0 applications usage situation survey' and the 'TPACK self-efficacy belief scale' were employed. Data obtained from the study group have been analysed with the 'SPSS Statistics 23' software, a t-test and the ANOVA test have been carried out, a Pearson correlation analysis and a Tamhane test has been conducted. The results show a significant relationship between TPACK self-efficacy belief levels and the variables involved in pre-service science teachers use of Web 2.0 applications.

Keywords: Science education, pre-service science teacher, technological pedagogical content knowledge (TPACK), self-efficacy beliefs, Web 2.0 applications.

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1. Introduction

1.1. Technology integration and technological pedagogical content knowledge

Using information and communications technologies (ICTs) as a tool to help students reach learning objectives, and to increase the success of students, also, technology use in the teaching–learning process is called technology integration (Usluel, Mumcu & Demiraslan, 2007). In schools, managers, teachers, students and parents are important stakeholders in technology integration, and they need to know and internalise the reasons why technology integration is being done. Among these stakeholders, teachers have great influence on student performance (Gibson & Dembo, 1984). Since instructional technology does not have a self-renewal feature, teachers are required to implement the curriculum in the classroom, to evaluate the learning process of the students and to integrate technology into their lessons to improve students' learning (Kumar, Rose & D'Silva, 2008). Therefore, it is important that the professional development of teachers is prioritised and supported by the administration.

New technological products and applications have affected the field of education (Akgunduz & Akinoglu, 2016), and with technology being used everywhere in our lives, it has become a necessity for teachers to provide education through technology integration (Akgunduz, 2016). It is a prerequisite for teachers, who are the leaders in the field of education (Lee & Reigeluth, 1994) to be technology literate and to raise literate students, in order to ensure that the course content is well understood, that learners are taught to use technology as a tool (Spazak, 2013) to enhance their learning and to develop high-level thinking skills. Teaching integration of technology opens the door to a world in which students learn to reach and achieve the right knowledge through accurate and responsible use of technology, contributes to gaining the 21st century skills and moves learning experience outside the walls of the classroom and help students learn on their own.

The technological tools that are used in every area in our life and which are increasing in number with scientific developments have started to become widespread in the field of science education (Tas, 2008). The multifaceted use of technological tools that are becoming widespread in the field of science makes it easier for students to understand concepts, embody abstract concepts, and thus, resulting in increased interest and curiosity towards science (Akpinar, Aktamis & Ergin, 2005). It provides students with a deeper understanding of topics when the technology integration is used in a student-centred and effective way in the learning–teaching process in science education (Bell & Bull, 2008). Using technologies for training is not about having high-end computers, using tablets and smart boards, or watching videos; it is about providing efficiency and supporting student achievements in curriculum through technological applications. In this regard, science teachers should be able to determine which technology should be used according to the difficulty levels of the subjects in their curriculum (McCrory, 2008).

Qualifications, competencies and experiences of teachers, who have key roles in the learning–teaching process, are important in planning and maintaining teaching activities in classroom. Prior to 1980, the competence in the field knowledge was taken as a basis for the qualified teacher concept (Shulman, 1986). However, teaching is complex, and teachers need to be able to present complex information in different situations and formats (Mishra & Koehler, 2006). After 1980, educational researchers started to believe that it is important for teachers to have pedagogical knowledge (PK) besides their field knowledge, in order to be able to teach in a meaningful and lasting manner (Feiman-Nemser & Buchman, 1987).

It is not enough for the teaching profession that teachers have considerable knowledge about their field or they are experts in their fields. Shulman (1986) defined the types of knowledge teacher should have as subject knowledge, curriculum knowledge and pedagogical content knowledge (PCK). According to Shulman (1987), a qualified teacher can teach by transforming the knowledge he has in such way that he can teach his students at different levels. Subject field experts see PCK as a mixture of PK and field knowledge, but PCK is not that simple, but rather complex? Purpose of the PCK is to show that how much the teacher knows about his/her field and his/her ability to teach in a way that is suitable for students' level and competence.

Research shows that technology enhances the level of learning together with teaching process, not by itself (Judson, 2006). In addition, technology integration deals with how much and why technology is used rather than the quantity and type of technology (Johnston & Moyer-Pachenham, 2012). Teacher candidates should be taught how to integrate technology with teaching processes, and the focus should not be on technology exclusively (Akgunduz, 2016). Teacher training programmes aimed at teaching only technological skills which are thought to be unsuccessful in transferring these abilities to teaching and learning environments (Koc & Bakir, 2010).

Koehler and Mishra (2005) suggest that teachers should possess the technological pedagogical content knowledge (TPACK) by integrating technological knowledge (TK) into the PCK added to the literature by Shulman in 1986. Turk Egitim Dernegi (2009) 'General competencies regarding the teaching profession' survey clearly states the importance of TPACK in teachers' professional success.

The concept of TPACK was first described by Pierson (1999) as a combination of PK, field knowledge and TK, and seeing technology integration as an important part of effective teaching. TPACK is a teacher information model, which is introduced by Mishra and Koehler (2006), which integrates TK into the concept of PCK developed by Shulman (1986) in parallel with technological developments. Content knowledge (CK), PK and TK that teachers need to possess are the integral elements of the TPACK model (Mishra & Kohler, 2006). TPACK is the knowledge that influences the understanding of the student by integrating technology and pedagogy in the teaching of a subject area (Graham et al., 2009). TPACK is the use of technology in planning, organising, criticising and summarising a subject, using the 21st century technologies to support the learning of students. A teacher with TPACK proficiency is aware of the effect of technology on the learning process of the student and has the ability to use the technology effectively and efficiently (Niess, 2008).

TPACK framework and knowledge components were created by Mishra and Koehler (2006). They consist of three basic components: a) CK: CK that teachers should have (Harris, Mishra & Koehler, 2007); b) PK: knowledge regarding implementation of teaching methods (Mishra & Koehler, 2006); c)TK: knowledge regarding adapting to and implementation of changing and developing technology (Schmidt et al., 2009).

TPACK and the types of interactive knowledge are shown in Figure 1 (Koehler & Mishra, 2009, p. 63).

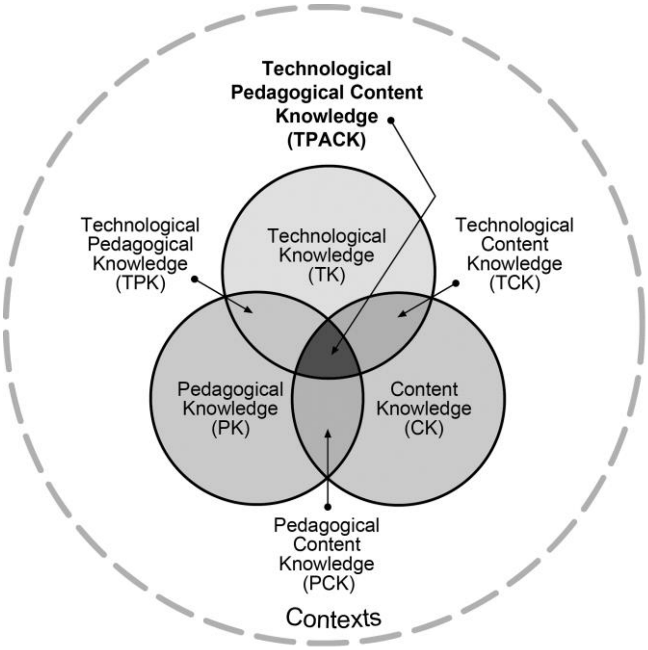

Figure 1. TPACK and the types of interactive knowledge (Koehler & Mishra, 2009)

TPACK is located in a common intersection area where PK, CK and TK interact with each other; PCK, technological content knowledge (TCK) and technological pedagogical knowledge (TPK) are formed from the interactions of these three information types.

1.2. Web 2.0 applications

It is observed that the technological tools are changed and developed every day by being influenced by the rapid development of the technology (Elmas & Geban, 2012). Web 2.0 applications, which includes developing technologies, are an umbrella term containing a wide range of applications (Horzum, 2010) and include many tools that are widely used today. The concept of Web 2.0 was first used by Tim O'Reilly in 2004 during a conference on the future of and the developments in the web (O'Reilly, 2007). Web 2.0, the second generation of WWW enables users to actively share information and ideas and collaborate (McLoughlin & Lee, 2007). With Web 2.0 applications, the web environment has changed from being an environment in which information is prepared and transmitted in previous static web pages, where communication is not available and ready information is consumed, and with dynamic web pages brought by Web 2.0, has evolved into a platform where content is generated, shared, merged and transferred with participants such as interactive communication, feedback to the target resource over the same page and sending information (Akcay, 2009; Akgunduz, 2013; Baytar, 2011; Horzum, 2010; Tu, Blocher & Roberts, 2008).

The most popular Web 2.0 applications are: blogs such as Twitter and Blogger; podcast and videocasts; information developing websites such as Wikipedia and other Wikis; social networks such as Facebook and Myspace; social tagging like Delicious; photo and video sharing such as Facebook and Flickr; RSS feeds for content collection and management; complex and integrated websites (Akgunduz, 2016; Akgunduz & Akinoglu, 2017; Genc, 2010; Greenhow, Robelia & Hughes, 2009).

Web 2.0 applications provide teachers and students the opportunity to create, manipulate and control content, socialise, and encourage students to be active participants in the classroom and contribute to the content (Hall, 2007). It is a fact that Web 2.0 applications will positively influence technological literacy levels, and that these tools, which will provide ease in the educational life of students, will play a critical role in preparing the 21st century business and education life by increasing creative and critical thinking skills (Elmas & Geban, 2012). The use of Web 2.0 applications has changed the life, school, classroom, how teachers work and the way the students learn (Akpinar et al., 2005). Teachers need to be influenced by this change and have more interest in Web 2.0 applications. Teachers should train students in creative thinking, problem-solving to become technology literate individuals with active participation, as well as to understand the content (Kale, 2013). Teachers should be able to choose technologies according to the characteristics of their students and follow new technologies in order to be able to use and teach them. Teachers should be informed about the technological changes related to in the education system and their skills of using developing tools should be increased (Turkmen, Pedersen & McCarty, 2007). Teachers will provide benefit for students when they have the ability to use Web 2.0 applications for their purposes (Lu, Lai & Law, 2010).

1.3. The aim and importance of the research

Regardless of his or her skill, there is no guarantee for success, if a person does not believe that he is capable of doing a job, does not have self-efficacy belief (Gawith, 1995). According to Bandura (1977), a person has the power to use his/her abilities effectively when he/she feels safe and sufficient in a situation. For this reason, it is necessary for the teachers to feel competent and secure in order to reach the technology, to use the technology and to integrate the new teaching technologies with the teaching processes effectively and efficiently.

The facts that technology is used in every field and is so closely related to new generation show that learning–teaching environments cannot be considered without technology. It is important that science teachers' have considerable TPACK knowledge and TPACK self-efficacy beliefs in order to be able to educate technology literate individuals by integrating technology into class environments and making learning–teaching environments as rich and efficient as the age requires. Because TPACK will ensure that technology integration, an important component for teaching, is effective (Kabakci Yurdakul, 2011; Koehler, Mishra & Yahya, 2007; Pierson, 1999). Technology enriches learning–teaching environments, but the importance of PK and CK to ensure teaching should not be forgotten. External factors such as hardware, software, etc., as well as internal factors such as self-efficacy, attitude, etc., also affect the use of technology in education and training (Ertmer, 2015). Schools' having good technological infrastructures is necessary for the use of technology in the education process, but it is not enough (Elmas & Geban, 2012). Teachers also need to feel sufficient regarding the internal factors. However, it is observed that teachers who think that they do not have the competency to effectively integrate technology into the learning–teaching process are reluctant to integrate technology (Collis & Moonen, 2008). According to Bandura (1977), a teacher with a high level of self-efficacy will be more willing and determined to create solutions to problems. Therefore, it is important for science teacher candidates and science teachers to want to use TPACK, introduced by Mishra and Koehler' (2006), which will enable them to reach the new generation of students and make their learning–teaching environment more effective, and for teachers to feel confident regarding TPACK, in other words, have considerable TPACK self-efficacy beliefs.

Researching for possible relationships between science teacher candidates' TPACK self-efficacy beliefs and how they use Web 2.0 applications; which they have free but sometimes limited access in their learning–teaching environments, can be used easily without any technical knowledge, have a user-friendly interface and bring a new dimension to education by enabling interaction and cooperation (Deperlioglu & Kose, 2010; Elmas & Geban, 2012; Horzum, 2010), will be useful for the literature. In addition, studying this relationship may provide new ways for educating teacher candidates in a way that enables them to have TPACK self-efficacy beliefs.

Therefore, this study aims to investigate on TPACK self-efficacy believes, TPACK self-efficacy belief levels and whether or not various factors affect these levels, and if there is a significant relationship between TPACK self-efficacy beliefs and competence in using Web 2.0 applications, thus, the study includes following questions:

1. Regarding science teacher candidates:
   a) What is the level of TPACK self-efficacy beliefs?
   b) Are the TPACK self-efficacy beliefs significantly different regarding gender, type of school they graduated from, personal computer and Internet ownership, level of computer use, weekly average computer use and weekly average Internet use?
2. Is there a relationship between the level of self-efficacy beliefs of science teacher candidates and how they use Web 2.0 applications (Web 2.0 applications usage time, Web 2.0 applications daily usage history, Web 2.0 applications educational usage history, Web 2.0 applications usage environment, Web 2.0 applications usage type, 'Web 2.0 usage purpose', 'popular and widely used Web 2.0 applications usage' and 'Web 2.0 applications usage perception')?

2. Method

2.1. Model of the study

The purpose was to gain knowledge about the teacher training system by determining the TPACK self-efficacy belief levels and the usage of Web 2.0 applications and determining whether there is a relationship between them, and thus, the research was conducted in accordance with the relational survey method, one of the general survey methods.

Surveys are usually conducted over a wide range of samples and are intended to determine the characteristics of the related parties, such as their views, interests, skills, abilities and attitudes. A single survey model, one of the general survey models, is a model in which a variable or variables are examined separately. The relational survey model is a model in which relationships between two or more variables are examined and identified (Buyukozturk, Kilic Cakmak, Akgun, Karadeniz & Demirel, 2013).

2.2. Study group

The study group consists of 344 volunteers, from six different universities, who study in Faculty of Education Science Education Department and who are in their last year in the 2017–2018 educational year. For the research, six universities have given the necessary permits to implement the study at the universities. Questionnaires and scales for the research were implemented by the researchers and volunteer teacher candidates answered those at six universities in the fall semester of the 2017–2018 academic year. 20.3% of the science teachers participating in the research are males (70 people) and 79.7% (274) are females.

2.3. Data collection tool

'Data collection form', which will be answered by final grade students of science education department, consists of three parts. 'personal information form' in the first section, 'Web 2.0 usage survey' in the second section and 'TPACK self-efficacy belief scale' in the third section.

2.3.1. Personal information form

The personal information form was prepared by the researchers by conducting literature searches and taking expert opinions. The personal information form contains articles for the personal information of prospective teachers; this information is determined by asking questions regarding gender, type of school they graduated, personal computer and Internet use, level of computer use, average computer usage and average Internet usage of the science teachers participating in the research.

2.3.2. Web 2.0 applications usage survey

The 'Web 2.0 applications usage situation survey' used in the research was developed by the researchers by studying the related literature. The survey is organised by the researchers and five academicians and four teachers from computer and educational technologies, educational technology, measurement and evaluation, Turkish language and literature and science education experts were interviewed to evaluate the clarity, appearance and content of the survey. The questionnaire was finalised with corrections made in line with expert opinions.

In the survey, questions 1–2 are about the frequency of using Web 2.0 applications, questions 3–4 are about the duration of use, questions 5–6 are about the usage environment, question 7 is on the type of use, question 8 is about the purpose of using (search, communication, production and entertainment), questions 9–16 are about the usage of popular and widely used Web 2.0 applications, question 17 is on the usage status of the Web 2.0 applications used for educational purposes and questions 18–30 are on the usage perception.

Cronbach's alpha (α) value of the Web 2.0 applications usage survey is in the range of 0.716, thus, the survey is considered reliable. It is considered highly reliable, since Cronbach's alpha (α) value of perception of Web 2.0 applications usage is 0.935, and the popular and the widely used Web 2.0 applications Cronbach's alpha (α) value is 0.935 (Kalayci, 2009).

2.3.3. Technological pedagogical content knowledge self-efficacy belief scale

The 'TPACK self-efficacy belief scale (TPACK-SBS)' is used without adaptation with permission from the developer, because of the fact that it includes articles specific to science department to determine the self-efficacy levels of prospective science teachers and it emphasises the self-efficacy beliefs.

The scale consists of 52 items and eight subsections: questions 1–8 are about PK, 9–14 are about CK, 15–24 are about PCK, 25–30 are about TK, 31–34 are about TCK, 35–41 are about TPK, 42–47 are about TPACK and 48–52 are questions about contextual knowledge.

TPACK-SBS consists of 10 step Likert articles, participants are asked to score between 0 and 100 according to the criteria 'I absolutely do not believe I can do it: 0' and 'I absolutely believe I can do it: 100'.

The Cronbach alpha internal consistency factor of the scale, developed by Canbazoglu Bilici (2012), is stated as 0.98. In this study, Cronbach alpha internal consistency factor of the scale was found to be 0.989.

3. Analysis of data

The data in the study has been entered into and analysed in the IBM SPSS 23 (Statistical Package for the Social Sciences) program. In the analysis of the data, percentage and frequency were used in order to show the gender information of science teachers.

Descriptive statistics of general and sub-dimensions have been made in order to determine TPACK self-efficacy belief levels of science teacher candidates. TPACK self-efficacy beliefs were examined according to demographic data. Since all data were found to have normal distribution, parametric tests were used in all analyses. Among parametric tests, independent sample *t*-test was performed to determine the difference between general and subscale of TPACK-SBS and its gender variations. The investigate of the differences between general TPACK-SBS and 'type of school graduated, personal computer and Internet ownership, level of computer use, average duration of computer use, average Internet usage time', from parametric tests, one-way ANOVA test was applied.

The investigate of the differences between general TPACK-SBS and 'history of using Web 2.0 applications in daily life, history of using Web 2.0 applications for educational purposes, usage environment of Web 2.0 applications, type of usage of Web 2.0 applications', from parametric tests, one-way ANOVA test was applied. The level of significance was taken as $p = 0.05$ in interpretation of the data in the study. Tamhane test was applied from post hoc tests to determine the significant difference between the variables. To determine the relationship between 'The aim for using Web 2.0 applications, the use of popular and widely used Web 2.0 applications, the perception of Web 2.0 applications usage' Pearson correlation analysis was applied.

4. Results and discussion

The first question of the research is 'a) What is the TPACK self-efficacy beliefs of science teacher candidates? and the second question is b) Does TPACK self-efficacy beliefs differ significantly depending on gender, type of school graduated, personal computer and Internet ownership, level of computer usage, average duration of computer usage and average Internet usage?'

Table 1. Descriptive statistics of general and sub-dimensions of TPACK-SBS

	N	Minimum	Maximum	Mean	Standard deviation
PK	344	3.25	10.00	7.9822	1.42736
TPK	344	3.00	10.00	7.9498	1.53627
PCK	344	3.00	10.00	7.9451	1.44851
Context	344	3.20	10.00	7.9413	1.54449
TPACK	344	3.17	10.00	7.8823	1.52257
TCK	344	2.00	10.00	7.8750	1.57987
TPACK self-efficacy belief	344	3.44	10.00	7.8340	1.36588
CK	344	3.33	10.00	7.8222	1.42810
TK	344	1.17	10.00	7.1633	1.73585

'PK' sub-dimension has the highest average in the TPACK-SBS (average: 7.9822). The lowest average is the 'TK' dimension (average: 7.1633). The 'general TPACK self-efficacy belief' level was found to be high (I believe I can) (average: 7.8340).

In this study, TPAB self-efficacy beliefs of science teacher candidates are generally high, 'I believe I can'. In the study of Bagriyanik (2015), the TPACK self-efficacy beliefs of the science teachers were as high as this study. In his studies that have mixed methods, Canbazoglu Bilici (2012), observes that TPACK self-efficacy beliefs of science teacher candidates increase as a result of the training. In Karakaya's study (2013), chemistry teachers' TPACK self-efficacy levels are not high enough. Avci (2014) found that science teachers are at a good level in all subscales of TPACK scale. As a result of his studies, Meric (2014) concluded that TPACK self-belief levels of science teacher candidates were high. Bilici and Guler (2016) determined that elementary school teachers have good results in all sub-dimension and the general of TPACK scale and see themselves at a sufficient level. Onal and Cakir (2015) have come to the conclusion that academics have moderate perceptions of self-efficacy regarding TPACK.

It has been found that, in the TPACK self-efficacy belief sub-dimensions, science teachers have the highest scores in 'PK' dimension (I believe I can), and the lowest scores in 'TK' dimension (I believe I can). In the study of Bagriyanik (2015), in accordance with this study, the second highest TPACK self-efficacy belief level was in the PK dimension and the lowest TPACK self-efficacy belief level was in the TK. In this study, it was observed that the science teacher candidates have the highest degree of confidence in the TK and the lowest level in PK. In the study of Bal and Karademir (2013), it was found that the teachers of social studies see themselves at a high level in terms of PK that they found themselves barely sufficient in terms of TK. Moreover, in the study of Bilici and Guler (2016), the average score of TK was lower than the other dimensions. Canbazoglu Bilici's study (2012) concluded that TK increases due to related training.

Table 2. TPAB SBS, general and sub-dimensions, and t-test results according to 'gender' variable

	Groups	*N*	$\bar{X}$	Std. deviation	*t*-Test *t*	SD	*p*
PK	Male	70	7.3857	1.66101	–3.500	92.531	0.001
	Female	274	8.1346	1.32208			
CK	Male	70	7.2548	1.64887	–3.347	93.232	0.001
	Female	274	7.9672	1.33102			
PCK	Male	70	7.2457	1.61808	–4.184	94.882	0.000
	Female	274	8.1237	1.34795			
TK	Male	70	7.0024	1.96538	–0.790	96.101	0.432
	Female	274	7.2044	1.67367			
TCK	Male	70	7.1143	1.73136	–4.236	96.340	0.000
	Female	274	8.0693	1.48056			
TPK	Male	70	7.3082	1.75817	–3.544	93.700	0.001
	Female	274	8.1137	1.43230			
TPACK	Male	70	7.3071	1.73266	–3.218	94.414	0.002
	Female	274	8.0292	1.43086			
Context	Male	70	7.2714	1.80660	–3.618	92.056	0.000
	Female	274	8.1124	1.42399			
TPACK self-efficacy belief	Male	70	7.2481	1.61686	–3.544	91.295	0.001
	Female	274	7.9837	1.25409			

A significant difference was found for all dimensions except for the 'TK' dimension, as a result of the independent sample *t*-test conducted to investigate the difference between TPACK self-efficacy beliefs, general and sub-dimensions and gender variation. The scores of women, in general and in sub-dimensions, were higher than men ($p < 0.05$). The science teacher candidates differed in general and sub-dimensions of TPACK self-efficacy belief, according to 'gender', except for the TK dimension. The TPACK self-efficacy beliefs of women, in general and in all sub-dimensions (except for the TK) are higher than men's averages. Contrary to this study, Avci (2014), in his work with science teachers, it was found that in all sub-dimensions of TPACK and self-efficacy scale; the average scores of male teachers were higher than those of female teachers. Significant results were seen in favour of men in other studies on technology sub-dimension (Bagriyanik, 2015; Bal & Karademir, 2013). On the other hand, Karakaya (2013) did not find any significant difference for chemistry teachers' TPACK self-efficacy regarding gender variation. In parallel with this study, in their study regarding TPACK self-efficacy, Lin, Tsai, Chai and Lee (2012) concluded that for science teachers and candidates, the female participants have higher self confidence regarding PK than male participants.

Table 3. One-way ANOVA test results according to TPACK-SBS and 'graduated school' variable

	Groups	*N*	$\bar{X}$	Std. deviation		Sum of square	df	Mean square	*F*	*p*
TPACK self-efficacy belief	Science high School	3	8.2436	0.89466	Between groups	17.329	5	3.466	1.882	0.097
	Anatolian High school	182	7.7047	1.36101						
	Anotolian teacher high school	30	8.2949	1.22428	Within groups	622.586	338	1.842		
	High school	108	7.7983	1.45566						
	Trade high school	13	8.4083	0.96330	Total	639.915	343			

Other	8	8.4447	0.79120
Total	344	7.8340	1.36588

In the one-way ANOVA test aimed to determine the difference between the general and the graduated school variant regarding the TPACK self-efficacy belief, there was not a significant difference ($P > 0.05$). TPACK self-efficacy belief does not change according to the school the candidates graduated from.

Table 4. One-way ANOVA test results according to TPACK-SBS and 'personal computer and personal Internet connection ownership status' variable

	Groups	*N*	$\bar{X}$	Std. deviation		Sum of square	df	Mean square	*F*	*p*
TPACK self-efficacy belief	Computer and Internet connection	287	7.9479	1.29319	Between groups	25.386	2	12.693	7.043	0.001
	Computer but no Internet connection	45	7.1436	1.65656	Within groups	614.529	341	1.802		
	Neither computer nor Internet connection	12	7.7003	1.18695	Total	639.915	343			
	Total	344	7.8340	1.36588						

One-way ANOVA test aimed to determine the difference between the TPACK self-efficacy beliefs in general and the 'personal computer and personal Internet connection' variant, revealed significant differences in TPACK self-efficacy beliefs between 'those with personal computer and Internet connections' and those without. TPAB self-efficacy belief overall scores of those who have personal computer and Internet connection are higher than the average score of 'those who have a computer but have no connection'. The TPACK self-efficacy belief is influenced by the Internet connection.

Table 5. One-way ANOVA test results according to TPACK-SBS and 'computer usage level' variable

	Groups	*N*	$\bar{X}$	Std. deviation		Sum of square	SD	Mean square	*F*	*p*
TPACK self-efficacy belief	Beginner	7	7.3407	1.45468	Between roups	43.553	3	14.518	8.277	0.000
	Intermediate	126	7.4095	1.53440						
	Proficient	183	8.0516	1.18486	Within groups	596.362	340	1.754		
	Advanced	28	8,.4457	1.11985						
	Total	344	7.8340	1.36588	Total	639.915	343			

A significant difference was found in the result of the one-way ANOVA test to determine the difference between TPACK self-efficacy beliefs in general and 'computer use level' variables ($p < 0.05$). As a result of the Tamhane test, for TPACK self-efficacy in general, this difference was found to be between the ones that have mediocre and good computer using skills and the ones with advanced skills. TPACK self-efficacy belief in general scores of those with advanced computer skills are better and higher than those of mediocre and good computer skills.

Table 6. One-way ANOVA test results according to the TPACK-SBS and the 'average duration of computer use' variable

Groups		*N*	$\bar{X}$	Std. deviation		Sum of square	df	Mean square	*F*	*p*
TPACK self-efficacy belief	Never	5	7.4654	0.58082	Between groups	2.381	4	0.595	0.316	0.867
	1–7 hours per week	195	7.8942	1.36943						
	8–21 hours per week	91	7.7320	1.45085	Within groups	637.534	339	1.881		
	22–35 hours per week	27	7.7949	1.14978						
	More than 35 hours per week	26	7.8513	1.39359	Total	639.915	343			
	Total	344	7.8340	1.36588						

One-way ANOVA test to determine the difference between the TPACK self-efficacy beliefs in general and the 'weekly computer use' variance was not significant (p > 0.05). TPACK self-efficacy belief does not change with the duration of computer use.

Table 7. One-way ANOVA test results according to TPACK-SBS and 'average Internet use time'

Groups		*N*	$\bar{X}$	Std. deviation		Sum of square	df	Mean square	*F*	*p*
TPACK self-efficacy belief	1–7 hours per week	67	7.3324	1.74435	Between groups	22.034	3	7.345	4.041	0.008
	8–21 hours per week	87	7.8652	1.11548						
	22–35 hours per week	84	7.9762	1.29854	Within groups	617.881	340	1.817		
	More than 35 hours per week	106	8.0129	1.27277						
	Total	344	7.8340	1.36588	Total	639.915	343			

A significant difference was found for the general as a result of the one-way ANOVA test to determine the difference between the TPACK self-efficacy beliefs in general and the 'average duration of Internet use' variant ($p < 0.05$). In order to determine the difference between these durations, 1–7 hours per week users, 22–35 hours per week users and 36 hours per week were compared, and it was found that 36 hours per week users have more favourable results in terms of average TPACK self-efficacy belief general score.

The second research question of the study is about whether there is a significant relationship between TPACK self-efficacy belief levels of science teacher candidates and their use of Web 2.0 applications. Because of this, the relationship between TPACK self-efficacy levels of science teacher candidates and Web 2.0 applications usage duration, Web 2.0 applications usage history, Web 2.0 applications educational usage history, Web 2.0 applications usage environment, Web 2.0 applications usage type, aim of using Web 2.0 applications, usage of popular and widely used Web 2.0 applications, perception of Web 2.0 applications usage, is studied.

Table 8. One-way ANOVA test results according to TPACK-SBS and 'Web 2.0 applications usage time' variable

	Groups	*N*	$\bar{X}$	Std. deviation		Sum of square	df	Mean square	*F*	*p*
TPACK self-efficacy belief	Never	8	7.1611	1.40232	Between groups	18.144	3	6.048	3.307	0.020
	Numerous times a month	111	7.9092	1.40113						
	Numerous times a week	130	7.6087	1.44671	Within Groups	621.771	340	1.829		
	Numerous times a day	95	8.1111	1.13955						
	Total	344	7.8340	1.36588	Total	639.915	343			

There was a significant difference ($p < 0.05$) as a result of the one-way ANOVA test to determine the difference between TPACK self-efficacy beliefs in general and 'Web 2.0 applications use time'. According to the Tamhane test, TPACK self-efficacy belief overall scores of those who use Web 2.0 application several times a day are significantly different from those who use it several times a week. Frequent use raises the TPACK self-efficacy belief.

Table 9. One-way ANOVA test results according to TPACK-SBS and 'Daily use history of Web 2.0 applications'

	Groups	*N*	$\bar{X}$	Std. deviation		Sum of square	df	Mean square	*F*	*p*
TPACK self-efficacy belief	Less than 1 year	63	7.4948	1.74609	Between groups	39.097	3	13.032	7.375	0.000
	From 1–3 years	89	7.4395	1.44420						
	From 3–6 years	100	8.0469	1.11782	Within groups	600.818	340	1.767		
	More than 6 years	92	8.2166	1.07185						
	Total	344	7.8340	1.36588	Total	639.915	343			

There was a significant difference ($p < 0.05$) in the result of the one-way ANOVA test to determine the difference between TPACK self-efficacy beliefs in general and 'Web 2.0 applications daily usage history'. In the Tamhane test, a significant difference in TPACK self-efficacy belief levels in general, was found between those who use Web 2.0 applications less than a year and more than 6 years; and those who use web 2.0 applications for 1–3 years and those who use 3–6 years and more than 6 years. TPACK self-efficacy belief overall scores of those who use Web 2.0 application for more than 6 years are higher than others. TPACK self-efficacy belief scores are increasing as the daily use of Web 2.0 applications increases.

Table 10. One-way ANOVA test results according to TPACK-SBS and 'Educational history of Web 2.0 applications'

	Groups	*N*	$\bar{X}$	Std. deviation		Sum of square	df	Mean square	*F*	*p*
TPACK self-efficacy belief	Never	11	6.2238	1.69231	Between groups	56.438	4	14.110	8.198	0.000
	Less than 1 year	73	7.5411	1.62122						
	From 1–3 years	99	7.6772	1.36121	Within groups	583.477	339	1.721		
	From 3–6 years	99	8.1218	0.98532						
	More than 6 years	62	8.2556	1.20701	Total	639.915	343			
	Total	344	7.8340	1.36588						

There was a significant difference ($p < 0.05$) in the result of the one-way ANOVA test to determine the difference between TPACK self-efficacy beliefs in general and 'Web 2.0 applications educational usage history'. In the Tamhane test, a significant difference in TPACK self-efficacy belief levels in general, was found between those who use Web 2.0 applications for educational purposes for less than a year and more than 6 years; and those who use web 2.0 applications for 1–3 years, 3–6 years and more than 6 years. TPACK self-efficacy belief overall scores of those who use Web 2.0 application for more than 6 years are higher than others. TPACK self-efficacy belief scores are increasing as the use of Web 2.0 applications for educational purposes increases.

Table 11. One-way ANOVA test results according to TPACK-SBS and 'Web 2.0 applications usage environments' variable

	Groups	*N*	$\bar{X}$	Std. deviation		Sum of square	df	Mean square	*F*	*p*
TPACK self-efficacy belief	Tablet	11	8.1836	1.03039	Between groups	2.885	3	0.962	0.513	0.673
	Mobile phone	146	7.7517	1.41173						
	Computer	183	7.8730	1.34171	Within groups	637.030	340	1.874		
	Other	4	8.0962	1.80721						
	Total	344	7.8340	1.36588	Total	639.915	343			

There was not a significant difference ($p > 0.05$) in the result of the one-way ANOVA test to determine the difference between TPACK self-efficacy beliefs in general and 'Web 2.0 usage environments' variant. Web 2.0 applications usage environment does not influence the TPACK self-efficacy belief.

Table 12. One-way ANOVA test results according to TPACK-SBS and 'Type of Web 2.0 applications usage'

	Groups	*N*	$\bar{X}$	Std. deviation		Sum of square	df	Mean square	*F*	*p*
TPACK self-efficacy belief	Producer	10	8.7346	0.89168	Between groups	23.800	2	11.900	6.586	0.002
	Consumer	292	7.7255	1.37604						
	Producer and consumer	42	8.3741	1.18888	Within groups	616.115	341	1.807		
	Total	344	7.8340	1.36588	Total	639.915	343			

There was a significant difference ($p < 0.05$) in the result of the one-way ANOVA test to determine the difference between TPACK self-efficacy beliefs in general and 'type of Web 2.0 applications usage'. As a result of the Tamhane test, it was determined that producers' TPACK self-efficacy belief overall average scores were significantly different from those of consumers. Using Web 2.0 applications as a producer influences TPACK self-efficacy beliefs positively.

The correlations were examined to determine whether there is a relationship between TPACK self-efficacy belief levels and 'usage of Web 2.0 applications', 'usage of popular and commonly used Web 2.0 Applications' and 'Web 2.0 applications usage perceptions'.

Table 13. Correlation analyse regarding the relationship between TPACK self-efficacy belief levels in general and in sub-dimensions and 'usage of Web 2.0 applications', 'usage of popular and widely used Web 2.0 applications', 'usage perceptions of Web 2.0 applications'

		The purpose of using Web 2.0 applications	Usage perceptions of Web 2.0 applications	Popular and widely used Web 2.0 applications
TPACK self-efficacy belief	Pearson correlation	0.144**	0.433**	0.278**
	p (2-tailed)	0.007	0.000	0.000
	N	344	344	344

**Correlation is significant at the 0.01 level (2-tailed).

TPACK self-efficacy beliefs have been found to be related with 'purpose of using Web 2.0 applications' ($r = 0.144$; $p = 0.007 < 0.05$). A positive relationship at a weak level has been found between TPACK self-efficacy in general and 'using the popular and the commonly used Web 2.0 applications' (r = 0.278; p = 0.00 < 0.05). A positive moderate relationship was found between TPACK self-efficacy beliefs in general and 'usage perceptions of Web 2.0 applications' ($r = 0.433$; $p = 0.00 < 0.05$).

Significant relationships between the use of web 2.0 applications and the TPACK self-efficacy beliefs of science teachers' candidates found in this study and the study conducted by Tatli, Ipek Akbulut and Altinisik (2016), that showed training of the prospective teachers in different departments in Web 2.0 applications resulted in a significant increase in their TPAB self-confidence levels, are in line with each other. In parallel with this study, Kabakci Yurdakul (2011) concluded that there is a significant relationship between the level of use of ICT technologies by teacher candidates and their technopedagogical education qualifications. Again, Chang, Tsai and Jang (2014) concluded that there was a difference between the TPACK of Taiwanese science teachers and the use of various ICT tools, which is also in line with this study. There was no significant relationship between TPACK self-efficacy beliefs and Web 2.0 applications according to the study, however, Alazcioglu (2016) found a relationship between TPACK proficiency levels of teacher candidates and their use of Web 2.0 applications. Albayrak, Canbazoglu Bilici, Baran and Ozbay (2016) found a positive relationship, for teachers in different fields, between teachers' proficiency in TPACK and their attitudes towards ICT and this is generally in line with this study.

5. Conclusion and recommendations

A significant relationship is found between teacher candidates' 'average time spent on Web 2.0 applications, time spent using Web 2.0 applications in day-to-day life, Web 2.0 applications educational usage history, usage variants of Web 2.0 applications and usage perceptions of Web 2.0 applications' and their TPACK self-efficacy beliefs.

There was a positive relationship between TPACK self-efficacy beliefs and 'the usage of popular and widely used Web 2.0 applications'. However, there was not a significant relationship between TPACK self-efficacy beliefs and 'Web 2.0 usage intentions' and 'the environments Web 2.0 applications most frequently used'.

At the end of the study, it was concluded that 'Web 2.0 applications' positively affect 'TPACK self-efficacy beliefs'; for this reason, educators and educational researchers should include Web 2.0 applications that are easy to use and engaging while making programs or while improving existing programs that enable science teacher candidates to integrate education with technology, and thus, contribute to the positive development of TPACK level of science teacher candidates.

Even if schools have technological equipment, Web 2.0 applications can be used to convince teachers to integrate technology into the educational process through the use of educational technologies. Teachers with high self-efficacy beliefs regarding TPACK can more easily integrate technology into the teaching process (Canbazoglu Bilici, Yamak, Kavak & Guzey, 2013).

Science teacher candidates can be encouraged to use easy-to-use Web 2.0 applications by incorporating them into educational process using their PK, in their future professions, and intensive use of Web 2.0 applications in undergraduate courses and internships can be done during undergraduate education in order to increase the TPACK self-efficacy beliefs of science teachers.

The separate courses in the faculty of education curriculum related to the CK, PK and usage of educational technologies may be integrated together in order for the science teacher candidates to have high TPACK self-efficacy beliefs. To support this study, Web 2.0 applications training can be given to prospective science teachers and the influence on TPACK self-efficacy belief can be measured afterwards. The different TPACK researches on the science-specific technologies and Web 2.0 applications will contribute to the field. This research is limited to undergraduate students, studying science education.

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