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An Investigation of Science Teachers' Web Pedagogical Content Knowledge

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Abstract

The purpose of this study was to investigate the web pedagogical content knowledge of science teachers. As a mixed method design, this study was carried out with science teachers. A total of 229 science teachers participated in the quantitative part of the study, and 17 science teachers with different year experience took part in the qualitative part. Quantitative data in the study were collected through the Web Pedagogical Content Knowledge Scale, and the qualitative data were collected by a semi-structured interview. The obtained quantitative data were analyzed using descriptive statistics, Mann-Whitney U test and Kruskal-Wallis H test. The content analysis was used on the qualitative data. The quantitative results of the research indicated that the levels of teachers' self-efficacy perceptions regarding web pedagogical content knowledge were very high. Moreover, the scores obtained from the overall scale and its sub-dimensions significantly differed with regards to work experience of science teachers. The qualitative findings of the study revealed that science teachers made use of the Web for lectures, experiments, practice, visual support, videos, and compensating the lack of materials. It was also emphasized that teachers should be educated to use the Web in their teaching practices.

Key words: *science teachers; web-based teaching; web pedagogical content knowledge; self-efficacy.*

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*This study is based on the master's thesis of Abdullah Balcı.

Introduction

Teaching is defined as the organization of information and environment for the purpose of learning. Media is not simply the place for teaching: it allows the provision of information and activities created in order to achieve intended, specific learning goals (Smith & Ragan, 1999), and it involves necessary methods, techniques and tools (Kaya, 2006). The type of knowledge teachers have affects the method, technique, and tools used in their teaching, and it has a role in the attainment of desired learning goals among students. Types of knowledge have varied and changed over time: in the past, teachers were first expected to have content knowledge; later, the focus has shifted to pedagogical knowledge, which indicates teaching capacity (Shulman, 1986; Beşoluk & Horzum, 2011). Shulman reported that having content knowledge (CK), which refers to knowledge about the actual subject matter, and pedagogical knowledge (PK), which includes application, process and teaching methods, is not sufficient and introduced pedagogical content knowledge as the combination of these two types of knowledge (PCK) (Shulman, 1986; 1987). PCK is the ability to choose and utilize the most useful forms of presenting topics, analogies, illustrations, explanations, examples, and demonstrations to make the subject comprehensible to others (Shulman, 1986).

With the advancement and proliferation of technology, the arguments concerning the necessity of technology in teaching have increased. New applications produced by new technologies have facilitated the implementation of PCK, and Technological Pedagogical Content Information (TPACK) has emerged with the integration of technology into the PCK model (Koehler & Mishra, 2005). TPACK refers to the integration of technology, pedagogy, and content knowledge in teaching a particular subject. Such knowledge is the knowledge of how the use of technological tools changes pedagogical strategies and content descriptions in the teaching of a subject (Jang & Chen, 2010). Various technologies ranging from conventional tools such as blackboards, chalks, paper, pencils, books and so on, to computers, digital videos and interactive boards, are employed in teaching (Koehler & Mishra, 2005; Koehler et al., 2007; Schmidt et al., 2009).

Internet is amongst the most effective technologies used in teaching (Özyalçın Oskay & Odabaşı, 2016). With its increasing role in every area of our lives, Internet plays an important role in access to information and new knowledge (Korucu, 2017) and allows for interaction with content and interpersonal communication (Horzum, 2011). As a part of the Interntet, World Wide Web can be used for different purposes, such as a source of information in teaching, the means of representing some content, the means of communication, or a site for collaboration (Wallace, 2004). Because of these features, the Web differs from other technologies, which has conditioned different structuring of the web TPACK (Lee et al., 2008; Lee & Tsai, 2010; Horzum, 2011). The model called Web Pedagogical Content Knowledge (TPCK-W) emerged as the integration of the PCK model by Shulman (1986) and the TPACK model by Mishra and Koehler (2006) (Lee et al., 2008; Lee & Tsai, 2010). There are three types of basic knowledge underlying the model of TPCK-W: web knowledge, pedagogical knowledge, and content knowledge (Figure 1). **Content knowledge (CK)** refers to subject matter to be learned or taught; **pedagogical knowledge (PK)** includes practices, processes, strategies, procedures, and methods of teaching; **web knowledge (WB)** involves information related to the advanced use of the web such as the general use of Web, the use of tools and applications related to Web, web-based communication or web-based interaction (Koehler &Mishra, 2005; Lee &Tsai, 2010).

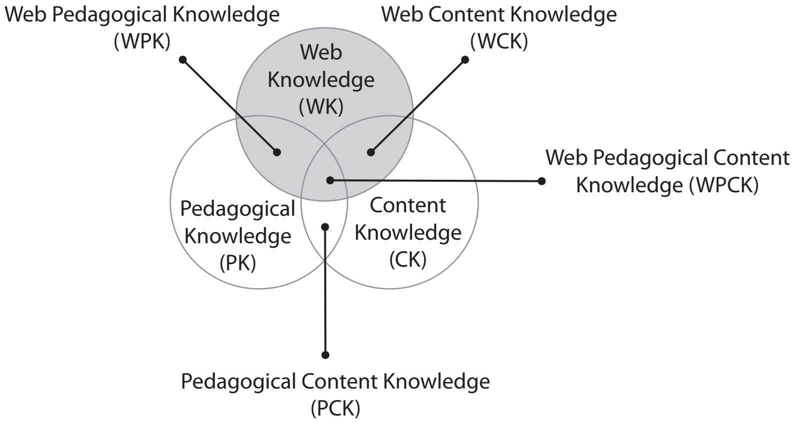

Figure 1. The Model of Web Pedagogical Content Knowledge (Lee & Tsai 2010)

TPCK-W emphasizes the connections and interaction between these three information components. The interaction between content knowledge, pedagogical knowledge, and web knowledge creates the concepts of *pedagogical content knowledge (PCK), web content knowledge (WCK), web pedagogical knowledge (WPK),* and *web pedagogical content knowledge* (TPCK-W). PCK is the knowledge that blends both content and pedagogy with the goal of developing better teaching practices in the content areas (Schmidt et al., 2009). WPK is the knowledge of the existence, components and capabilities of Web, as used by teachers in the teaching settings (Lee & Tsai, 2010). It is specific knowledge of how to use a piece of technology, selected by teachers for teaching, to ensure a better understanding of this technology among students (Wallace, 2004). WCK is the teacher's knowledge on how to integrate the features and advantages of the web into the content. TPCK-W is the blend of web knowledge, pedagogical knowledge, and content knowledge (Lee &Tsai, 2010).

Another important matter in web-based instruction are the levels of teachers' self-efficacy perceptions regarding their TPCK-W. Self-efficacy is the belief of an individual about his/her ability to overcome the situations they may potentially encounter in the future (Senemoğlu, 2012). This belief affects the individual's attempt to carry out a relevant action and his/her persistence and performance regarding the action (Canbazoğlu Bilici, 2012). When the teachers with a high self-efficacy perception regarding their TPCK-W encounter a problem in web-based instruction, they will be more willing and determined to solve the problem. This will have a positive impact on the quality and prevalence of web-based instruction.

The studies on TPCK-W in the relevant literature can be grouped under three headings: the studies analyzing the level of self-efficacy perception with respect to TPCK-W and investigating whether it varies according to various variables (Lee & Tsai, 2010; Barış, 2015; Kavanoz et al., 2015; Özyalçın Oskay & Odabaşı, 2016; Turan & Koç, 2016; Korucu, 2017), the studies revealing various models related to TPCK-W (Horzum & Canan Güngören, 2012; Canan Güngören & Horzum, 2015; Gökçearslan et al., 2016; Zhou et al., 2017), and the experimental studies examining the change in the level of self-efficacy perception regarding TPCK-W (Akayuure et al., 2013; Yazar & Şimşek, 2015).

In general, these studies analyzed the level of participants' self-efficacy perception in terms of their TPCK-W and revealed whether it varied according to various variables such as seniority, age, the subject they teach, internet use, and so on. Yet, there have been no studies on the impact of workplace and previous education in web-based instruction on the level of self-efficacy perception with respect to TPCK-W. Furthermore, no study has examined the factors affecting the level of participants' self-efficacy perception in terms of their TPCK-W. The sample of the existing studies mostly consisted of pre-service teachers, or they did not include science teachers.

This being said, the present study sought to probe into the level of science teachers' self-efficacy perceptions regarding their TPCK-W, the factors affecting the self-efficacy perception of their TPCK-W, the impact of TPCK-W on web-based instruction as well as the teachers' views on web-based instruction. Therefore, the study will potentially add to the literature by popularizing and enhancing web-based instruction.

The aim of the study

The aim of this study was to analyze the web pedagogical content knowledge of science teachers. To that end, the study sought to answer the following questions about the science teachers:

1. What are the levels of their self-efficacy perceptions regarding their TPCK-W?
   1.1. Do the levels of their self-efficacy perceptions regarding their TPCK-W significantly vary depending on:
      a. seniority,
      b. time spent on the Internet;
   1.2. What are their views on the factors affecting their self-efficacy perceptions in terms of their TPCK-W?
2. What are their views on the impact of TPCK-W on web-based instruction?
   2.1. What are the underlying reasons for their views on the impact of TPCK-W on web-based instruction?

3. What are their views on web-based instruction?
   3.1. Why do they benefit from web-based instruction?
   3.2. What are their views on the positive and negative aspects of web-based instruction?
   3.3. What are their views on the problems they encountered in web-based instruction?
   3.4. What are their views on the factors affecting their self-efficacy perceptions regarding TPCK-W?

Methods

Research design

This study, which aimed to analyze the web pedagogical content knowledge of the science teachers, employed a mixed-method approach. Mixed methods provide more comprehensive information on a research problem using quantitative and qualitative methods, approaches, and concepts together in a single study or series of studies (Gökçek, 2014; Creswell, 2014).

Research group

The research group consisted of the science teachers working in secondary schools of Tokat in Turkey, in 2016-2017. The quantitative part of the study was carried out with 229 science teachers. Table 1 demonstrates the demographic information regarding the teachers who participated in the quantitative part.

Table 1

Demographic Information regarding the teachers who participated in the quantitative part of the study

Variabe	Groups	N	%
Gender	Male	122	53,3
	Female	107	46,7
Seniority	0-5 years	71	31,0
	6-10 years	70	30,6
	11-15 years	48	21,0
	16-20 years	22	9,6
	21 years or more	18	7,9
Weekly Internet/Web Use	0-3 hours	43	18,8
	4-6 hours	55	24,0
	7-9 hours	47	20,5
	10 hours or more	84	36,7

The qualitative part of the study was conducted with 17 science teachers who were selected by means of purposive sampling, based on their educational status, seniority, and workplace. Table 2 shows the information regarding the teachers who participated in the qualitative part of the study.

Table 2

Demographic information about the teachers who participated in the qualitative part of the study

Variable	Groups	N	%
Gender	Male	8	47,0
	Female	9	53,0
Seniority	0-5 years	4	23,5
	6-10 years	6	35,3
	11-15 years	3	17,6
	16-20 years	2	11,8
	21 years or more	2	11,8

Instruments

To collect the data in the study, we used the personal information form, Web Pedagogical Content Knowledge Scale, and the interview regarding web pedagogical content knowledge.

Personal information form

The personal information form, which was designed to obtain the demographic data about the participants, included questions regarding gender, seniority, weekly internet/web use, and previous education in the use of web-based instruction.

Web Pedagogical Content Knowledge Scale

Web Pedagogical Content Knowledge Scale was developed by Lee and Tsai (2010) and adapted to Turkish by Horzum (2011). The scale is comprised of 30 items and five factors: *Web General*, *Web-Communicative*, *Web Content*, *Web Pedagogical Content,* and *Attitude towards Web-Based Instruction.* The scale is a 5-point Likert type scale ranging from "strongly disagree (1)" to "strongly agree (5)". The overall reliability coefficient of the Horzum's scale was 0.94, and the reliability coefficients for the subdimensions of the scale were 0.88 (web general), 0.91 (web-communicative), 0.95 (web content), 0.90 (web pedagogical content), and 0.92 (attitude towards web-based instruction). Based on the data from the 229 science teachers whom the scale was administered to, the overall reliability coefficient was 0.95, and the reliability coefficients of the subdimensions were 0.83 (web general), 0.91 (web-communicative), 0.88 (web content), 0.99 (web pedagogical content), and 0.90 (attitude towards web-based instruction), which indicates high reliability.

The interview about Web pedagogical content knowledge

The study utilized a semi-structured interview form consisting of eight questions prepared by the researchers and reviewed based on expert opinions in order to analyze the TPCK-W of the science teachers in the qualitative part of the study.

Data analysis

Analysis of quantitative data

The analysis of the obtained data was performed by means of the statistical package program.

The study utilized the methods of descriptive statistics to reveal and examine the differences between the groups in terms of demographic variables.

Since the data of the study did not meet parametric test assumptions, the Mann Whitney U-test and the Kruskal Wallis H test were carried out. If the Kruskal Wallis H test reveals differences, Mann Whitney U test is performed with Bonferroni adjustment to determine which groups are different from each other (Güriş & Astar, 2015). The significance level in the analyses performed in the study was considered as p=0, 05.

Analysis of qualitative data

The content analysis was used to process the data obtained from the interviews.

The coding in the analyses was performed independently by different coders, and their codes were compared to test the reliability of the study. The cases where the coders use the same code were considered as "Consensus" whilst the cases where the coders use different codes were considered as "Dissension." The reliability of the data analysis was calculated using the following formula proposed by Miles and Huberman (2004): "Reliability= Consensus / (Consensus + Dissension) x 100", and the resulting reliability rate was 90.2%. An inter-coder reliability of a minimum of 70% is acceptable for qualitative studies. Thus, it was evident that the qualitative part of the study was reliable.

Results

Findings of the quantitative part of the study

Table 3 presents the results of descriptive statistics regarding the level of the science teachers' self-efficacy perceptions regarding their TPCK-W.

Table 3

Descriptive statistics regarding the level of the science teachers' self-efficacy perceptions of their TPCK-W

	Minimum	Maximum	$\overline{X}$	SS
Web General	2,57	5,00	4,73	0,42
Web-Communicative	1,00	5,00	4,16	0,99
Web Content	2,20	5,00	4,64	0,53
Web Pedagogical Content	2,75	5,00	4,51	0,57
Attitude towards WBI	2,00	5,00	4,59	0,53
TPCK-W (Overall Scale)	2,67	5,00	4,55	0,48

As seen in Table 3, the level of the participants' self-efficacy perceptions in terms of their TPCK-W falls into the level of "strongly agree" ($\overline{X}$ $\overline{X}$=4,55), which means that their perceptions are considerably high. As for the subdimensions of the scale, the participants' self-efficacy perceptions for web general, web content, web pedagogical content, and attitude towards WBI are $\overline{X}\overline{X}$ =4,73, $\overline{X}\overline{X}$=4,64, $\overline{X}\overline{X}$=4,51, and $\overline{X}\overline{X}$=4,59, respectively, which are considerably high. As for the dimension of web-communicative, the level of their self-efficacy perceptions is $\overline{X}\overline{X}$=4,16, which is also considered high.

Table 4 shows the results for descriptive statistics and the Kruskal Wallis H test regarding the level of the participants' self-efficacy perceptions for the subdimensions and in the overall TPCK-W according to seniority.

Table 4

Results for descriptive statistics and the Kruskal Wallis H Test regarding the level of the science teachers' self-efficacy perceptions according to seniority

	Seniority	N	$\bar{X}$	SS	Mean Rank	sd	χ^2	p
Web General	0-5 years	71	4,77	0,36	118,58	4	15,47	0,004*
	6-10 years	70	4,79	0,34	120,65			
	11-15 years	48	4,80	0,37	124,00			
	16-20 years	22	4,71	0,40	108,52			
	21 years or more	18	4,24	0,72	62,83			
Web-Communi-cative	0-5 years	71	4,39	0,75	126,72	4	17,32	0,002*
	6-10 years	70	4,30	0,88	121,77			
	11-15 years	48	4,12	1,01	113,95			
	16-20 years	22	3,81	1,31	102,41			
	21 years or more	18	3,23	1,12	60,64			
Web Content	0-5 years	71	4,69	0,44	118,00	4	11,76	0,019*
	6-10 years	70	4,69	0,46	120,30			
	11-15 years	48	4,68	0,55	121,91			
	16-20 years	22	4,59	0,65	110,68			
	21 years or more	18	4,17	0,70	69,42			
Web Pedagogical Content	0-5 years	71	4,54	0,56	119,78	4	11,31	0,023*
	6-10 years	70	4,62	0,47	124,66			
	11-15 years	48	4,54	0,50	114,90			
	16-20 years	22	4,44	0,61	105,39			
	21 years or more	18	3,99	0,80	70,58			
Attitude towards WBI	0-5 years	71	4,63	0,53	120,01	4	10,63	0,031*
	6-10 years	70	4,68	0,43	123,60			
	11-15 years	48	4,62	0,46	118,55			
	16-20 years	22	4,39	0,67	93,98			
	21 years or more	18	4,21	0,72	78,03			
TPCK-W (Overall Scale)	0-5 years	71	4,62	0,43	123,62	4	15,02	0,005*
	6-10 years	70	4,64	0,39	124,53			
	11-15 years	48	4,58	0,41	114,53			
	16-20 years	22	4,43	0,56	100,50			
	21 years or more	18	4,02	0,67	62,92			

*p<0,05

According to Table 6, there is a significant difference detected between the teachers with work experience of 0-5 years, 6-10 years, and 11-15 years, and the teachers with seniority of 21 years or more for Web General, Web-Communicative, Web Content subdimensions, and in the overall TPCK-W. This significant difference was in favor of science teachers with 0-5 years, 6-10 years, and 11-15 years of work experience. Besides, there was a significant difference between the teachers with 0-5 and 6-10 years of work experience and the teachers with 21 years or more work experience for Web Pedagogical Content subdimension. This significant difference was in favor of science teachers with 0-5 years and 6-10 years of work experience. In addition, there was a significant difference detected between the teachers with seniority of 6-10 years and the ones with seniortiy of 21 years and more for Attitude towards WBI subdimension. This significant difference was in favor of science teachers with 6-10 years in service.

Table 5 demonstrates the results of descriptive statistics and the Kruskal Wallis H test regarding the level of the science teachers' self-efficacy perceptions concerning their TPCK-W according to weekly internet use.

Table 5

Results of descriptive statistics and the Kruskal Wallis H test regarding the level of the science teachers' self-efficacy perceptions according to the variable weekly internet use

	Weekly Internet Use	N	$\bar{X}$	SS	Mean Rank	sd	χ^2	p
Web General	0-3 hours	43	4,67	0,52	110,93	3	3,61	0,306
	4-6 hours	55	4,62	0,55	103,37			
	7-9 hours	47	4,79	0,35	122,28			
	10 hours or more	84	4,83	0,27	120,63			
Web-communicative	0-3 hours	43	3,79	1,18	94,51	3	11,22	0,011*
	4-6 hours	55	4,04	0,96	105,02			
	7-9 hours	47	4,23	0,89	116,84			
	10 hours or more	84	4,39	0,91	130,99			
Web Content	0-3 hours	43	4,55	0,62	105,24	3	9,28	0,026*
	4-6 hours	55	4,49	0,62	98,54			
	7-9 hours	47	4,69	0,47	120,87			
	10 hours or more	84	4,76	0,42	127,49			
Web Pedagogical Content	0-3 hours	43	4,40	0,63	103,37	3	9,18	0,027*
	4-6 hours	55	4,37	0,62	98,85			
	7-9 hours	47	4,60	0,49	120,07			
	10 hours or more	84	4,63	0,53	128,68			
Attitude towards WBI	0-3 hours	43	4,44	0,60	97,98	3	12,10	0,007*
	4-6 hours	55	4,43	0,64	98,99			
	7-9 hours	47	4,70	0,42	123,16			
	10 hours or more	84	4,71	0,45	129,63			
TPCK-W (Overall Scale)	0-3 hours	43	4,41	0,55	96,87	3	13,48	0,004*
	4-6 hours	55	4,42	0,56	97,87			
	7-9 hours	47	4,63	0,40	119,47			
	10 hours or more	84	4,68	0,39	132,99			

*p<0,05

As seen in Table 5, levels of the science teachers' self-efficacy perceptions in the overall TPCK-W and the subdimensions, except Web General, vary according to weekly internet use. The results pointed out that self-efficacy perception levels of the science teachers who used the Internet for 10 hours or more per week for TPCK-W were significantly higher than those who used the Internet for 0-3 hours and for 4-6 hours per week.

Findings of the qualitative part of the study

Table 6 indicates the themes, subthemes, and codes based on the views on the factors affecting the science teachers' self-efficacy perceptions in web-based instruction.

Table 6
Factors affecting the self-efficacy perceptions in web-based instruction

Themes	Subthemes	Codes
Factors affecting the self-efficacy perceptions in web-based instruction	Professional characteristics of the teachers	Effect of the field they teach (Science)
		Foreign language
		Active use of web
		Educational background
	Demographic characteristics of the teachers	Age

The teachers reported that the field they teach (science), knowledge of a foreign language, active use of the Web, educational background regarding web, and age had an impact on the self-efficacy level in web-based instruction.

One of the participants, T10, stated, "It is, so to say, a must in the field of science. Science is a course linked to technology to a certain extent. I think this has an impact."

Table 7 indicates the themes, subthemes and codes based on the underlying reasons for the science teachers' views on the impact of TPCK-W on web-based instruction.

Table 7
Underlying reasons for the views on the impact of TPCK-W on web-based instruction

Themes	Subthemes	Codes
Underlying reasons for the views	Underlying reasons for the views that it has an impact	Education trends (for present and future)
		Preparing relevant course material
		Indirect experiences
	Underlying reasons for the views that it has a partial impact	Other variables effective in instruction
	Underlying reasons for the views that it does not have an impact	Resistance to web-based instruction
		Ease in using the existing web applications
		Other variables effective in instruction

Science teachers who stated that their web pedagogical content knowledge affected their implementation of web-based instruction emphasized that web-based instruction is the present and future trend in education and that, if they have a higher level of TPCK-W, they can prepare relevant course material. They had the chance to look at the applications developed by the teachers good at using web tools. In that regard, these teachers made the following statements:

"Certainly. I believe that this will be the style of education of the future." ***T6***

The teachers who stated that web pedagogical content knowledge had a partial impact on the implementation of web-based instruction emphasized that web is a useful tool for teaching, and that there are many factors affecting teaching. They made the following statements:

"I think the main factor in the content of the course is information itself. İnformation and teaching methods... Web is just one of those elements…" ***T5***

The teachers who stated that web pedagogical content knowledge did not have an impact on the implementation of web-based instruction expressed that there is no need for web-based instruction, the existing web tools and applications are easy to use, and web is not essential for teaching.

"I think the use of web is an additional method in the course. I don't think using the web is necessary for the course." ***T13***

Table 8 demonstrates the themes, subthemes and codes based on the answers to about the reasons for using web-based instruction (how they used web during their courses).

Table 8
Reasons for using web-based instruction

Themes	Subthemes	Codes
Reasons for using web-based instruction	Interactive teaching	Lecturing
		Difficult and challenging experiments
	Practicing	Solving problems
		Visual support
	Rich stimuli	Video viewing
		Compensating for insufficient materials

Regarding the reasons for using web-based instruction, the teachers expressed that they used web to offer difficult and challenging experiments, solve questions, provide visual support, and compensate for insufficient materials.

"We don't have many opportunities to do experiments at school. We don't have a laboratory at school. We have the chance to do such experiments on the Web." ***T2***

Table 9 shows the themes, subthemes and codes based on the science teachers' answers regarding the positive aspects of web-based instruction.

Table 9
Positive aspects of web-based instruction

Themes	Subthemes	Codes
Positive aspects of web-based instruction	Saving	Material Ease of access to information Time
	Rich stimuli	Concretization Visual support
	Permanent learning	Frequent review of subject matter Motivation
	Enabling students to keep up with the times	–

The science teachers stated that web-based instruction saves time and material and allows for ease of access to information. One of the statements is:

"It saves time because you need to organize and place the materials in a class of 40-45 students for an experiment, and you might lose control of your classroom while doing that. However, when you demonstrate the necessary via the Internet, a visual of an experiment, it saves a considerable amount of time and also allows the empowerment of the subject content." ***T6***

Moreover, the teachers reported that web-based instruction is useful to concretize the subject matter, provide visual support, ensure frequent review of the subject matter, motivate students, and enable them to keep up with the era.

"In this day and age, it is not possible to provide education without technology. If one teaches without using technology, he or she will raise a generation behind the times." ***T17***

Table 10 indicates the themes, subthemes, and codes based on the science teachers' answers to the question on the negative aspects of web-based instruction.

Table 10
Negative aspects of web-based instruction

Themes	Subthemes
Negative aspects of web-based instruction	Disrupting the course Need for preliminary preparation Getting used to taking the easy way out

Regarding the negative aspects of web-based instruction, the teachers expressed that it disrupts the course, requires preliminary preparation, and means getting used to taking the easy way out, and they made the following statements:

"As the students are not conscious enough, I feel like they sometimes use it to disrupt the course, as if it was a game." ***T1***

Table 11 shows the themes, subthemes, and codes based on the science teachers' answers about the problems they encountered in web-based instruction.

Table 11
Problems in web-based instruction

Themes	Subthemes	Codes
Problems in web-based instruction	Technical problems	Lack of internet access
		Insufficient technical equipment
		Blocked websites
	Problems with class management	Disruption of classroom order

The science teachers reported that they encountered some technical problems while performing web-based instruction, such as lack of internet access, insufficient technical equipment, and blocked websites. They made the following statements regarding the problems:

"We sometimes experience interruptions of the internet connection due to infrastructure." ***T9***

The teachers reflected on the problems they encountered in class management during web-based instruction as follows:

"When there is internet access in class or when I demonstrate something via Internet, the class discipline is disrupted more than usual. It is a disadvantage." ***T13***

Table 12 demonstrates the themes, subthemes and codes based on the science teachers' views on the factors affecting web-based instruction.

Table 12.
Factors affecting web-based instruction

Themes	Subthemes	Codes
Factors affecting web-based instruction	Teacher	Self-efficacy level
		Web knowledge
		Collaboration with colleagues
	Infrastructure	Internet access
		Class size

Teachers were proven to be the foremost factor affecting web-based instruction. Self-efficacy levels of the science teachers in web-based instruction, their web knowledge, and collaboration with colleagues had a positive influence on the implementation of web-based instruction. Moreover, internet access and class size were considered as the factors influencing web-based instruction, which is reflected in one of the tachers' statements:

"One can integrate an application previously used for different purposes into the activities in the science course. I believe that the know-how of using the Web has a positive effect on this process." ***T11***

Discussion and conclusion

The present study revealed that the level of the science teachers' self-efficacy perceptions in web pedagogical content knowledge fell into the level of "strongly agree", which meant that their perceptions were considerably high. To put it more explicitly, the levels of the science teachers' self-efficacy perceptions in the subdimensions of the scale, which were web general, web content, web pedagogical content, and attitude towards WBI were considerably high. As for the subdimension of web-communicative, the level of their self-efficacy perceptions was high. It has been reported that the individuals with high self-efficacy in any subject are more willing to participate in the activities related to the subject and when faced with a challenge, these individuals overcome it more easily (Akkoyunlu & Kurbanoğlu, 2004). For that reason, it is paramount that the levels of the science teachers' self-efficacy perceptions regarding their TPCK-W were high. Bandura (1995) argued that there are mainly four sources of self-efficacy perception. These sources are: the individual's past performance accomplishments (direct experiences-personal experiences), the accomplishments of others as observed by the individual (vicarious experiences), verbal feedback given by a third party to strengthen the belief that the individual has certain skills, and the psychological situation in which the individual performs an action. The active use of web in daily life and the educational background of the teachers present experiences in themselves. This seems to be the reason why the levels of the science teachers' self-efficacy perceptions for web-based instruction are high. In the literature, there are findings showing that the levels of the in-service and pre-service teachers' self-efficacy perceptions for using web pedagogical content knowledge are high (Lee & Tsai, 2010; Barış, 2015; Kavanoz et al., 2015; Yazar & Şimşek, 2015; Özyalçın Oskay & Odabaşı, 2016; Turan & Koç, 2016). Therefore, the findings of this study are congruent with previous research.

There were significant differences between the levels of the science teachers' self-efficacy perceptions for using the overall TPCK-W, and all subdimensions significantly varied according to seniority. The self-efficacy perceptions of the teachers with a seniority of 0-5 years, 6-10 years, and 11-15 years for using TPCK-W were significantly higher than the perceptions of the teachers with a seniority of 21 years and more. It can be argued that the reason for such finding may be the new generation, grownig up with technology and being more adaptable to it. The study by Lee and Tsai (2010) determined a significantly negative correlation between the seniority of teachers and their self-efficacy levels for using TPCK-W, which is in line with the results of the present study. The study by Barış (2015) and Korucu (2017) with teachers of different subjects revealed that there is no significant difference in terms of seniority, which is a finding congruent with the results of the present study.

There was a significant difference in the levels of the science teachers' self-efficacy perceptions for TPCK-W and subdimensions, except Web General, according to the variable of web experience. The results pointed out that the self-efficacy perception levels of the science teachers who use the Internet for 10 hours or more per week about using TPCK-W were significantly higher than of those who use the Internet for 0-3 hours and 4-6 hours per week. There are similar findings of other studies in the literature (Yazar & Şimşek, 2015; Turan & Koç, 2016). Lee and Tsai (2010) reported a significantly positive correlation between teachers' web experience and their self-efficacy levels for using TPCK-W. Thus it can be stated that teachers' web experience has a significantly positive impact on their self-efficacy levels for using TPCK-W.

The participants stated that their web pedagogical content knowledge had either an impact or a partial impact or did not have an impact on the implementation of web-based instruction. The participants who reported that their web pedagogical content knowledge had an impact on their implementation of web-based instruction explained that web-based instruction is the present and future trend in education and that, if they have a higher level of TPCK-W, they can prepare relevant course material and also review and use the applications developed by their collegues good at using web tools. Canan Güngören and Horzum (2015) reported that the web pedagogical content knowledge of pre-service teachers had a positive effect on the use of the Internet in their future profession. Moreover, Zhou et al. (2017) found out that the web pedagogical content knowledge of teachers is a powerful predictor of their online homework guidance quality. These findings are congruent with the results of the current study. The teachers who stated that web pedagogical content knowledge had a partial impact on the implementation of web-based instruction emphasized that web is a useful tool for teaching, and there are numerous factors affecting teaching. The teachers who stated that web pedagogical content knowledge did not have an impact on the implementation of web-based instruction expressed that there is no need for web-based instruction, the existing web tools and applications are easy to use, and web is not essential for teaching.

The study ascertained that the participants used web-based instruction for various purposes such as lecturing, doing experiments, solving problems, providing visual support, video viewing, and compensating for insufficient materials. Furthermore, they stated that they performed experiments on web or showed the experiments performed on web because of the lack of laboratories in their schools, insufficient materials, and dangerous nature of experiments. They also reported that they enabled students to become more active by solving problems, and those different problems and tests enhanced their perspective. There is a myriad of visual, dynamic and abstract subjects encompassed by the filed of science. Materials are of great use to convey visual, dynamic or abstract subjects and to make these subjects more comprehensible for students (Kahyaoğlu, 2011). The inability to bring all the materials, including the costly and difficult-to-access materials related to the subject into the classroom further necessitated the need for web-based instruction. Hence, web can be used to provide visual support and compensate for insufficient materials during courses. The teachers also stated that they used web to convey information about the subject matter and to share the videos of experiments with students.

In the interviews with the science teachers, they mentioned the positive aspects of web-based instruction such as ease of access to information, concretization, visual support, economizing time and material, frequent review of the subject matter, motivation for students, and helping students gain technological skills. The involvement of technology in the course of science and the importance of being a technology literate in today's society require students to gain technological skills. Çetin et al. (2013) stated that web-based instruction enhances one's technology literacy. The learning area of "information" encompassed by the scientific field consists of the subareas of living things and life, matter and change, and physical phenomena, as well as the Earth and the universe (MEB, 2013). Web is certainly useful for teachinig these areas since it allows for easy access to information, concretization, and visual support.

The participants mentioned some negative aspects of web-based instruction. They stated that it disrupts the course, requires preliminary preparation, and means getting used to taking the easy way out. It is notable that these negative aspects are caused by teachers or students, and that they can be eliminated by teachers.

The participants listed the following problems in web-based instruction: technical problems and disrupting discipline in the classroom, the lack of internet access, insufficient technical equipment and blocked websites equipment and blocked websites. The ban imposed on certain websites by the Turkish Ministry of Education for various reasons can be reviewed in order for the teachers to gain access to some of these websites that would potentially be beneficial. Teachers can report these websites through prescribed channels and to proper authorities and thus contribute to eliminating this issue. The disruption of classroom discipline, which was one of the negative aspects identified by the participants, can be prevented by teachers themselves.

The findings revealed that teachers are the foremost factor affecting web-based instruction. The self-efficacy levels of the participants in using their web knowledge and collaboration with colleagues play an effective role in the implementation of web-based instruction. Internet access and class size are considered as the aspects of infrastructure. The teachers expressed that they experienced problems with internet connectivity at the schools outside the center, and that IT teachers at schools play an important role in web-based instruction.

Suggestions

Technical improvements necessary for web-based instruction can be made across schools in Turkey. Educational websites can be improved in terms of both quantity and quality. More effective web tools or applications on subject matters can be developed with the collaboration of teachers and software specialists.

Experimental studies should be carried out to observe the change in the web pedagogical content knowledge of teachers. Further studies may elaborate the factors affecting the level of teachers' self-efficacy perceptions for using web pedagogical content knowledge.

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Istraživanje poznavanja mrežnoga pedagoškog sadržaja nastavnika prirodnih predmeta

Sažetak

Cilj ovoga istraživanja bio je ispitati poznavanje mrežnoga pedagoškog sadržaja nastavnika prirodnih predmeta. Istraživanje je zasnovano na dizajnu miješanih metoda i provedeno je s uzorkom nastavnika prirodnih predmeta, koji je obuhvatio ukupno 229 nastavnika u kvalitativnom dijelu studije i 17 nastavnika prirodnih predmeta, s različitim iskustvom, u kvalitativnom dijelu istraživanja. Kvantitativni podatci u istraživanju sakupljeni su upotrebom Skale poznavanja mrežnoga pedagoškog sadržaja, a kvalitativni podatci sakupljeni su polustrukturiranim intervjuom. Deskriptivne statistika, Mann-Whitney U test i Kruskal-Wallis H test upotrijebljeni su za analizu kvantitativnih podataka, a metodom analize sadržaja obrađeni su kvalitativni podatci. Kvantitativni rezultati istraživanja pokazuju vrlo visoke razine percepcije samoučinkovitosti vezane za poznavanje mrežnoga pedagoškog sadržaja nastavnika prirodnih predmeta. Osim toga, rezultati dobiveni primjenom sveukupne Skale i njezinih poddimenzija značajno se razlikuju s obzirom na iskustvo nastavnika. Kvalitativni rezultati studije otkrili su da nastavnici prirodnih predmeta koriste mrežu za predavanja, eksperimente, praksu, vizualnu podršku, videozapise i kompenzaciju manjka materijala. Također je naglašeno da nastavnici trebaju biti obrazovani kako bi koristili mrežu u svojim praksama poučavanja.

Ključne riječi: *nastavnici prirodnih predmeta; mrežno potpomognuto poučavanje; poznavanje mrežnoga pedagoškog sadržaja; samoučinkovitost.*

Uvod

Poučavanje je definirano kao organizacija informacija i okolina poučavanja sa svrhom učenja. Sredstva se ne odnose samo na mjesto poučavanja, već također predstavljaju informacije i aktivnosti kreirane kako bi se olakšalo ostvarivanje planiranih, specifičnih ciljeva učenja (Smith i Ragan, 1999), a uključuju potrebne metode, tehnike i alate (Kaya, 2006). Vrsta znanja učitelja utječe na metode, tehnike i alate koje upotrebljava u poučavanju te ima ulogu u stjecanju željenih ciljeva među učenicima. Vrste znanja mijenjale su se i varirale tijekom vremena. U prošlosti od učitelja se prvenstveno očekivalo poznavanje sadržaja; kasnije se fokus pomaknuo na pedagoško znanje koje je pokazatelj sposobnosti poučavanja (Shulman, 1986; Beşoluk i Horzum, 2011). Shulman navodi kako nije dovoljno poznavanje sadržaja (PS), tj. poznavanje stvarne predmetne građe i pedagoško znanje (PZ), odnosno primjena, proces i metode poučavanja te je predstavio pojam poznavanja pedagoškog sadržaja, kao kombinaciju dva spomenuta tipa znanja (PPS) (Shulman, 1986; 1987). PPS je sposobnost odabira i upotrebe korisnih oblika predstavljanja tema, analogija, ilustracija, objašnjenja, primjera i demonstracija, kako bi se predmet učinio razumljivim (Shulman, 1986).

S razvojem i napretkom tehnologije jačaju i argumenti njezine nužnosti u poučavanju. Aplikacije stvorene zahvaljujući novoj tehnologiji omogućile su primjenu PPS-a, pa se tako, integracijom tehnologije u PPS model, pojavio model poznavanja tehnološko-pedagoškog sadržaja (PTPS) (Koehler i Mishra, 2005). PTPS odnosi se na integraciju tehnologije, pedagogije i poznavanja sadržaja u poučavanju određenoga predmeta. To je znanje o načinu na koji je upotreba tehnoloških alata promijenila pedagoške strategije i opise sadržaja u poučavanju nekog predmeta (Jang i Chen, 2010). U poučavanju koriste se razne tehnike: preko konvencionalnih alata poput ploča, krede, papira, olovke i knjige do računala, digitalnih videa i interaktivnih ploča (Koehler i Mishra, 2005; Koehler i sur., 2007; Schmidt i sur., 2009).

Internet je jedna od najučinkovitijih tehnologija koje se koriste u poučavanju (Özyalçın Oskay i Odabaşı, 2016). Sve veća uloga interneta u svim područjima naših života čini ga važnim u pristupu informacijama i novom znanju (Korucu, 2017); postaje moderator interakcije sa sadržajem i interpersonalne komunikacije (Horzum, 2011). Kao dio interneta, World Wide Web (svjetska mreža, tj. web) može se koristiti kao izvor informacija u poučavanju, sredstvo predstavljanja sadržaja, sredstvo komunikacije ili mjesto suradnje (Wallace, 2004). Zbog tih se osobina mreža razlikuje od drugih tehnologija, što je uvjetovalo drugačije strukturiranje mrežnoga PTPS-a (Lee, Tsai i Chang 2008; Lee i Tsai, 2010; Horzum, 2011). Model koji se pojavio na presjeku modela PPS-a Shulmana (1986) i modela PTPS-a Mishrae i Koehleraand (2006) naziva se poznavanje mrežnoga pedagoškog sadržaja (PMPS)[1] (Lee i sur., 2008; Lee i Tsai, 2010). Tri su vrste osnovnoga znanja u podlozi PMPS modela: poznavanje mreže, pedagoško znanje i poznavanje sadržaja (Slika 1). **Poznavanje sadržaja (PS)** odnosi se na predmetnu građu koja se uči ili poučava; **pedagoško znanje (PZ)** uključuje prakse, procese, strategije i metode poučavanja; **poznavanje mreže (PM)** obuhvaća informacije o naprednoj upotrebi *weba* poput opće upotrebe svjetske mreže, korištenja alata i aplikacija na *webu* i komunikaciju ili interakciju na mreži (Koehler i Mishra, 2005; Lee i Tsai, 2010).

Slika 1.

[1] Napomena prevoditelja: Model poznavanja mrežnoga pedagoškog sadžaja u hrvatskom tekstu je preveden akronimom PMPS (u originalu je to TPACK; vidi rad na engleskom). Svi ostali akronimi u hrvatskom tekstu su pokrate hrvatskoga nazivlja, tj. prevedenih engleskih naziva.

Model PMPS-a naglašava veze i interakciju između tri navedene informacijske sastavnice: interakcija između poznavanja sadržaja, pedagoškoga znanja i mrežnoga znanja stvara koncepte *poznavanja pedagoškoga sadržaja (PPS), poznavanja mrežnoga sadržaja (PMS), mrežnoga pedagoškog znanja* (MPZ) i *poznavanja mrežnoga pedagoškog sadržaja (PMPS).* PPS je znanje koje obuhvaća i sadržaj i pedagogiju, s ciljem razvijanja boljih praksi poučavanja u predmetnim područjima (Schmidt i sur., 2009). MPZ je znanje o postojanju, sastavnicama i mogućnostima mreže, kako ga upotrebljavaju učitelji u okolinama poučavanja (Lee i Tsai, 2010): to je specifično znanje o načinima korištenja tehnologije koju biraju učitelji u svrhu poučavanja kako bi osigurali bolje razumijevanje odabrane tehnologije među učenicima (Wallace, 2004). PMS obuhvaća razumijevanje načina korištenja osobina i prednosti mreže u obradi predmetne građe. PMPS je spoj poznavanja mreže, pedagoškoga znanja i poznavanja sadržaja (Lee i Tsai, 2010).

Učiteljska razina samoučinkovitosti u korištenju PMPS-a od velike je važnosti u mrežnom poučavanju. Samoučinkovitost je vjerovanje osobe u vlastite sposobnosti rješavanja situacija s kojima će se moguće susretati u budućnosti (Senemoğlu, 2012). Ovo vjerovanje utječe na pokušaj osobe da poduzme relevantne radnje i ustrajnost u njihovoj izvedbi (Canbazoğlu Bilici, 2012). Kada se učitelji s visokom percepcijom samoučinkovitosti vezanom za PMPS susretnu s problemom u mrežnom poučavanju, imat će više volje i odlučnosti u rješavanju problema, što pozitivno utječe na kvalitetu i učestalost mrežne poduke.

Istraživanja o PMPS-u u relevantnoj literaturi mogu se svrstati u tri grupe: istraživanja koja analiziraju razinu percepcije samoučinkovitosti u odnosu na PMPS i ispituju mijenja li se ista u odnosu na razne varijable (Lee i Tsai, 2010; Barış, 2015; Kavanoz, Yüksel i Özcan, 2015; Özyalçın Oskay i Odabaşı, 2016; Turan i Koç, 2016; Korucu, 2017), istraživanja koja ispituju razne modele povezane s PMPS-om (Horzum i Canan Güngören, 2012; Canan Güngören i Horzum, 2015; Gökçearslan i sur. 2016; Zhou i sur., 2017), i eksperimentalne studije koje ispituju promjenu u razini percepcije samoučinkovitosti u odnosu na PMPS (Akayuure i sur., 2013; Yazar i Şimşek, 2015).

Općenito, ova istraživanja analizirala su razinu percepcije samoučinkovitosti u odnosu na PMPS sudionika i ustanovile razlikuju li se te percepcije u odnosu na različite varijable poput staža, dobi, predmetnoga područja, upotrebe interneta itd. Provedena korištenjem kvantitativnih metoda ova su istraživanja predstavila različite rezultate na osnovi varijabli poput dužine radnoga staža, mrežnoga iskustva itd. Unatoč tome, ne postoje istraživanja učinka radnoga mjesta i prethodnoga obrazovanja na mrežnu pouku. Osim toga, ni jedno istraživanje nije ispitivalo faktore koji utječu na razinu percepcije samoučinkovitosti vezane za PMPS. Uzorak postojećih istraživanja većinom je uključivao studente nije obuhvatio nastavnike prirodnih predmeta.

S obzirom na navedeno, ovim se istraživanjem nastojala utvrditi razina percepcije samoučinkovitosti nastavnika prirodnih predmeta u odnosu na PMPS, utjecaj PMPS-a na mrežno potpomognuto poučavanje kao i njihove stavove o mrežnom poučavanju, što će potencijalno doprinijeti literaturi popularizirajući i unapređujući poučavanje na mreži.

Cilj istraživanja

Cilj istraživanja bio je analizirati poznavanje mrežnoga pedagoškog sadržaja nastavnika prirodnih predmeta. S obzirom na cilj, postavljena su sljedeća istraživačka pitanja o nastavnicima prirodnih predmeta:

1. Koje su razine njihove percepcije samoučinkovitosti u odnosu na PMPS?
    1.1. Razlikuju li se značajno razine njihove percepcije samoučinkovitosti u odnosu na PMPS ovisno o:
        a) duljini radnog staža
        b) vremenu provedenom na internetu
    1.2. Koji su njihovi pogledi na čimbenike koji utječu na percepciju samoučinkovitosti vezane za PMPS?
2. Koji su njihovi pogledi na učinak PMPS-a na mrežno poučavanje?
    2.1. Koje je porijeklo njihovih gledišta o učinku PMPS-a na mrežno poučavanje?
3. Koja su njihova stajališta o mrežnom poučavanju?
    3.1 Koje su koristi mrežnoga poučavanja?
    3.2. Koja su njihova gledišta na pozitivne i negativne aspekte mrežnoga poučavanja?
    3.3. Koji su njihovi pogledi na probleme s kojima se susreću u mrežnom poučavanju?
    3.4. Koja su njihova stajališta o čimbenicima koji utječu na percepciju samoučinkovitosti u odnosu na PMPS?

Metode

Dizajn istraživanja

Ovo istraživanje imalo je svrhu analizirati poznavanje mrežnoga pedagoškog sadržaja nastavnika prirodnih predmeta. Istraživanje se zasnivalo na pristupu miješanih metoda koje osiguravaju prikupljanje sveobuhvatnijih informacija o problemu istraživanja putem upotrebe kvantitativnih i kvalitativnih metoda, pristupa i koncepata objedinjenih u jednoj studiji ili nizu studija (Gökçek, 2014; Creswell, 2014).

Uzorak

Uzorak istraživanja obuhvatio je nastavnike prirodnih predmeta iz srednjih škola u Tokatu u Turskoj (2016 .- 2017.). U kvantitativnom dijelu studije sudjelovalo je 229 profesora prirodnih predmeta čiji su demografski podatci prikazani u Tablici 1.

Tablica 1.

Kvalitativni dio studije proveden je sa 17 nastavnika koji su odabrani metodom namjernoga uzorka, na osnovi stupnja obrazovanja, duljine radnoga staža i radnoga mjesta. U Tablici 2 prikazane su informacije o nastavnicima koji su sudjelovali u kvalitativnom dijelu studije.

Tablica 2.

Instrumenti

Upotrijebljeni alati za prikupljanje podataka u istraživanju su obrazac s osobnim podatcima, Skala poznavanja mrežnoga pedagoškog sadržaja i intervju o poznavanju mrežnoga pedagoškog sadržaja.

Obrazac s osobnim podatcima

Unaprijed pripremljeni obrazac, sa svrhom prikupljanja demografskih podataka o sudionicima, sadržavao je pitanja o spolu, dužini radnoga staža, tjednoj upotrebi mreže/interneta i dodatnom obrazovanju u području mrežnoga poučavanja.

Skala poznavanja mrežnoga pedagoškog sadržaja (SPMPS)

Skalu poznavanja mrežnoga pedagoškog sadržaja (SPMPS) kreirali su Lee i sur., a za potrebe ovoga istraživanja prilagodio ju je Horzum (2011). Skala se sastoji od 30 stavki i pet faktora: *mreža općenito, komunikativnost na mreži, mrežni sadržaj, mrežni pedagoški sadržaj* i *stavovi o mrežnom poučavanju.* Sudionici su procjenjivali stavke na petostupanjskoj Likertovoj skali u rasponu od izrazitoga slaganja (1) do izrazitoga neslaganja (5). Sveukupni koeficijent pouzdanosti Horzumove skale bio je 0,94, a koeficijenti pouzdanosti za poddimenzije skale 0,88, 0,91, 0,95, 0,90 i 0,92, tim redoslijedom. Na osnovi podataka dobivenih od 229 nastavnika prirodnih predmeta, na kojima je instrument primijenjen, sveukupni koeficijent pouzdanosti bio je 0,95, a koeficijenti za poddimenzije 0,83 (mreža općenito), 0,91 (komunikativnost na mreži), 0,88 (mrežni sadržaj), 0,99 (mrežni pedagoški sadržaj) i 0,90 (stavovi o mrežnom poučavanju), što pokazuje visoku pouzdanost.

Pitanja intervjua o poznavanju mrežnoga pedagoškog sadržaja

U istraživanju je upotrijebljen polustrukturirani obrazac intervjua koji se sastojao od osam pitanja, a pripremili su ga istraživači na osnovi pregleda literature i stručnih mišljenja, s ciljem analize poznavanja mrežnoga pedagoškog sadržaja nastavnika prirodnih predmeta u kvalitativnom dijelu studije.

Analiza podataka

Analiza kvantitativnih podataka

Analiza podataka dobivenih u istraživanju provedena je putem statističkoga programa. Podatci su analizirani metodama deskriptivne statistike.

U istraživanju su upotrijebljene statističke metode kojima su se nastojale utvrditi razlike između grupa s obzirom na demografske varijable.

Budući da podatci u istraživanju nisu zadovoljili pretpostavke parametrijskoga testiranja, provedeni su Mann Whitney U-test i Kruskal Wallis H test. Kada se Kruskal Wallis H testom ustanove razlike, provodi se Mann Whitney U test s Bonferroni prilagodbom kako bi se utvrdilo koje se grupe međusobno razlikuju (Güriş i Astar, 2015). Razmatrana razina značajnosti analiza provedenih u istraživanju je $p = 0,05$.

Analiza kvalitativnih podataka

Podatci dobiveni u intervjuima istraživanja obrađeni su metodom analize sadržaja, odnosno istraživačkom metodom za donošenje zaključaka o sadržaju podataka.

Kodiranje u analizama neovisno su radili različiti stručnjaci, a njihovi kodovi su uspoređeni kako bi se testirala pouzdanost studije. Slučajevi u kojima su se upotrebljavali isti kodovi bili su smatrani „suglasnošću", dok su slučajevi u kojima su se upotrebljavali različite kodovi razmatrani „nesuglasnošću". Pouzdanost analize podatka izračunata je formulom koju su razvili Miles i Huberman (2004): pouzdanost = suglasnost/(suglasnost + nesuglasnost) x 100", a rezultat stope pouzdanosti bio je 90,2 %. Prihvaćena pouzdanost između istraživača koji rade kodiranje je minimalno 70 % za kvalitativna istraživanja, stoga je pouzdanost kvalitativnoga dijela istraživanja očita.

Rezultati

Rezultati kvantitativnoga dijela istraživanja

U Tablici 3 prikazani su rezultati deskriptivne statistike o razini percepcija samoučinkovitosti nastavnika prirodnih predmeta u odnosu na PMPS.

Tablica 3.

Kao što je vidljivo iz Tablice 3, razina percepcija samoučinkovitosti u odnosu na PMPS sudionika spada u razinu izrazitoga slaganja ($\bar{X}$ $\bar{X}$ = 4,55), što znači da su njihove percepcije izrazito visoke. Što se tiče poddimenzija skale, razina percepcije samoučinkovitosti sudionika za mrežu općenito, mrežni sadržaj, mrežni pedagoški sadržaj i stav prema MPP-u je $\bar{X}$ $\bar{X}$ = 4,73, $\bar{X}$ $\bar{X}$ = 4,64, $\bar{X}$ $\bar{X}$ = 4,51 i $\bar{X}$ $\bar{X}$ = 4,59, tim redoslijedom, što je prilično visoko. Kada govorimo o dimenziji komunikativnosti na mreži, razina percepcija samoučinkovitosti sudionika je visoka i iznosi $\bar{X}$ $\bar{X}$ = 4,16.

U Tablici 4 prikazani su rezultati deskriptivne statistike i Kruskal Wallis H testa s obzirom na razinu percepcije samoučinkovitosti sudionika za poddimenzije i cjelokupnu skalu PMPS-a prema varijabli duljine radnoga staža.

Tablica 4.

Kao što je vidljivo iz rezultata u Tablici 6, ustanovljena je značajna razlika između razina percepcije samoučinkovitosti nastavnika s 0 - 5, 6 - 10 i 11 - 15 godina radnoga staža i učitelja s 21 godinom i više radnoga iskustva za poddimenzije mreža općenito, komunikativnost na mreži, mrežni sadržaj i sveukupnu skalu PMPS, u korist prve tri skupine učitelja koji imaju višu razinu percepcija samoučinkovitosti u spomenutim dimenzijama. Osim toga, rezultati pokazuju značajno više percepcije samoučinkovitosti u poddimenziji mrežnoga pedagoškog sadržaja učitelja s 0 - 5 i 6 - 10 godina staža od onih s 21 godinom i više radnoga iskustva. Nadalje, rezultati pokazuju da učitelji sa 6 - 10 godina radnoga staža imaju značajno više percepcije samoučinkovitosti za poddimenziju stav prema MPP-u od učitelja s 21 i više godina radnoga iskustva.

U Tablici 5 prikazani su rezultati deskriptivne statistike i Kruskal Wallis H testa s obzirom na razine percepcije samoučinkovitosti u odnosu na PMPS nastavnika prirodnih predmeta prema varijabli tjedne upotrebe interneta.

Tablica 5.

Kao što je vidljivo iz Tablice 5, razine percepcija samoučinkovitosti nastavnika prirodnih predmeta u sveukupnoj skali PMPS-a i ostalim poddimenzijama, osim mreže općenito, variraju prema tjednoj upotrebi interneta. Rezultati pokazuju da su percepcije nastavnika koji koriste internet 10 ili više sati tjedno značajno više od onih koji ga koriste 0 - 3 sata ili 4 - 6 sati tjedno.

Rezultati kvalitativnoga dijela istraživanja

U Tablici 6 prikazane su teme, podteme i kodovi u odnosu na poglede nastavnika na faktore koji utječu na njihove percepcije samoučinkovitosti u mrežno potpomognutom poučavanju.

Tablica 6.

Nastavnici su izjavili da su područje/predmet, znanje stranoga jezika, aktivno korištenje mreže, obrazovanje u području *weba* i dob imali utjecaj na razinu percepcije samoučinkovitosti u mrežno potpomognutom poučavanju.

Jedan je od sudionika, T10, izjavio: „To je, tako reći, obavezno polje u znanosti. Prirodni predmeti u određenoj su mjeri povezani s tehnologijom. Mislim da to ima utjecaja."

U Tablici 7 prikazane su teme, podteme i kodovi zasnovani na temeljnim razlozima za stavove nastavnika prirodnih predmeta o utjecaju PMPS-a na mrežno potpomognuto poučavanje.

Tablica 7.

Nastavnici prirodnih predmeta koji su izjavili da njihovo poznavanje mrežnoga pedagoškog sadržaja ima utjecaja na primjenu mrežnoga poučavanja naglasili su da je mrežno potpomognuta nastava sadašnji i budući trend u obrazovanju i da s visokom razinom PMPS-a mogu pripremati relevantan nastavni materijal. Imali su priliku pogledati aplikacije koje su razvili učitelji vješti s mrežnim alatima. U tom pogledu, ovi su nastavnici izjavili:

„Svakako. Vjerujem da će to biti stil obrazovanja budućnosti." ***T6***

Nastavnici koji su izjavili da poznavanje mrežnoga pedagoškog sadržaja ima djelomičan učinak na primjenu mrežnoga poučavanja naglasili su da je mreža koristan alat za poučavanje i da su čimbenici koji utječu na nastavu mnogi:

„Smatram da je glavni faktor u sadržaju nastave sama informacija: informacija i metode poučavanja. Mreža je samo jedan od tih elemenata…" ***T5***

Nastavnici koji su izjavili da poznavanje mrežnoga pedagoškog sadržaja nema utjecaja na primjenu mrežnoga poučavanja izrazili su da nema potrebe za mrežno potpomognutom nastavom, da su postojeći mrežni alati i aplikacije lagani za korištenje i da mreža nije neophodna za poučavanje:

„Mislim da je korištenje weba dodatna metoda u nastavi. Ne vjerujem da je upotreba weba neophodna za nastavu." ***T13***

U Tablici 8 prikazane su teme, podteme i kodovi odgovora nastavnika prirodnih predmeta o razlozima provedbe mrežno potpomognutoga poučavanja (kako koriste mrežu tijekom nastave).

Tablica 8.

S obzirom na razloge provedbe mrežno potpomognute nastave, učitelji su izrazili da upotrebljavaju mrežu kako bi predstavili teške i izazovne eksperimente, riješili pitanja, osigurali vizualnu podršku i gledanje videozapisa te kompenzirali nedostatne materijale.

„Nemamo mnogo prilike raditi eksperimente u školi. Nemamo laboratorij u školi. Imamo priliku raditi eksperimente na mreži." ***T2***

U Tablici 9 prikazane su teme, podteme i kodovi zasnovani na odgovorima nastavnika o pozitivnim aspektima mrežnoga poučavanja.

Tablica 9.

Nastavnici prirodnih predmeta izjavili su da mrežno potpomognuta nastava štedi vrijeme i materijale te olakšava pristup informacijama:

„Štedi vrijeme: za eksperiment trebate organizirati mjesto i materijale u razredu od 40 do 45 učenika i gubite kontrolu nad učenicima dok to radite. Ali, kada tijekom nastave pokažete potrebno na internetu, poput vizualnog prikaza ili eksperimenta, štedite znatnu količinu vremena i kvalitetnije pristupate predmetnoj temi." ***T6***

Osim toga, nastavnici su izvijestili da je mrežno potpomognuto poučavanje korisna za konkretizaciju predmetne građe, daje vizualnu podršku, osigurava česti pregled predmetne građe, motivira učenike i omogućuje im da budu ukorak s vremenom.

„U današnje vrijeme, obrazovanje nije moguće bez tehnologije. Ako poučavamo bez upotrebe tehnologije, odgojit ćemo generaciju zaostalu za vremenom." ***T17***

U Tablici 10 su prikazane teme, podteme i kodovi zasnovani na nastavničkim odgovorima o negativnim aspektima mrežno potpomognutoga poučavanja.

Tablica 10.

S obzirom na negativne aspekte mrežnoga poučavanja, nastavnici su izjavili da ometa nastavu, zahtijeva prethodnu pripremu i znači navikavanje na liniju manjeg otpora:

„Budući da učenici nisu dovoljno osviješteni, smatram da to ponekad koriste kako bi ometali nastavu, kao da je to igra." ***T1***

U Tablici 11 prikazane su teme, podteme i kodovi na osnovi nastavničkih odgovora o problemima koje susreću u mrežno potpomognutom poučavanju.

Tablica 11.

Nastavnici su izvijestili da susreću neke tehničke probleme dok izvode nastavu na mreži, poput nedostatne dostupnosti interneta, nedovoljne tehničke opreme i blokiranih mrežnih stranica. U vezi s tim izjavili su sljedeće:

*„Ponekad imamo prekide internetske veze zbog infrastrukture." **T9***

Nastavnici su opisali probleme koje susreću u mrežno potpomognutoj nastavi vezane uz upravljanje razredom kako slijedi:

*„Kada u razredu imamo pristup internetu ili kada nešto pokazujem na internetu, disciplina u razredu je lošija. To je nedostatak." **T13***

U Tablici 12 prikazane su teme, podteme i kodovi zasnovani na nastavničkim pogledima na čimbenike utjecaja na mrežno poučavanje.

Tablica 12.

Nastavnici su najvažniji faktor utjecaja na mrežno poučavanje. Razine samoučinkovitosti nastavnika prirodnih predmeta u mrežnom poučavanju, njihovo poznavanje mreže i suradnja s kolegama igrali su važnu ulogu u primjeni mrežnoga poučavanja. Osim toga, pristup internetu i veličina razreda čimbenici su koji utječu na mrežno poučavanje. Učitelji su izjavili:

*„U prirodnim predmetima možemo primijeniti aplikaciju koja se prethodno koristila za druge svrhe. Vjerujem da znanje o korištenju mreže ima pozitivan učinak u tome." **T11***

Rasprava i zaključak

Rezultati ovoga istraživanja pokazuju da su razine percepcije nastavnika prirodnih predmeta samoučinkovitosti vezane za poznavanja mrežnoga pedagoškog sadržaja u kategoriji jakog slaganja, što znači da su značajno visoke. Eksplicitnije rečeno, razine percepcija samoučinkovitosti nastavnika prirodnih predmeta za sve poddimenzije skale – mreža općenito, mrežni sadržaj, mrežni pedagoški sadržaj i stav prema mrežno potpomognutom poučavanju – vrlo su visoke. S obzirom na poddimenziju komunikativnosti na mreži, razine percepcije samoučinkovitosti nastavnika bile su visoke. Rezultati govore da su pojedinci samoučinkoviti u bilo kojem predmetu voljniji sudjelovati u aktivnostima povezanim s predmetom i lakše svladavaju izazove kada su s njima suočeni (Akkoyunlu i Kurbanoğlu, 2004). Stoga, činjenica je da su percepcije samoučinkovitosti nastavnika prirodnih predmeta vezane za PMPS bile visoke. Bandura (1995) navodi četiri izvora percepcije samoučinkovitosti: prethodna osobna postignuća (direktna iskustva-osobna iskustva), postignuća drugih kako ih doživljava pojedinac (indirektna iskustva), verbalna povratna informacija koja osnažuje vjerovanje u određenu vještinu i psihološka situacija u kojoj pojedinac djeluje. Aktivna upotreba mreže u svakodnevnom životu i obrazovanje nastavnika čine zasebna iskustva, što predstavlja razlog za tako visoke razine samopercepcije nastavnika prirodnih predmeta učinkovitosti u mrežnom poučavanju. U literaturi se navode rezultati koji pokazuju da su razine percepcije samoučinkovitosti nastavnika i budućih nastavnika vezane za poznavanje mrežnoga pedagoškog sadržaja visoke (Lee i Tsai, 2010; Barış, 2015; Kavanoz i sur., 2015; Yazar i Şimşek, 2015; Özyalçın Oskay i Odabaşı, 2016; Turan i Koç, 2016). S obzirom na to, rezultati ovoga istraživanja sukladni su prethodnim istraživanjima u literaturi.

S obzirom na duljinu radnoga staža, značajne su razlike između razina percepcija samoučinkovitosti nastavnika prirodnih predmeta u odnosu na PMPS općenito i u svim poddimenzijama. Percepcije samoučinkovitosti učitelja s 0 - 5 godina, 6 - 10 godina i 11 - 15 godina radnoga staža značajno su više nego percepcije učitelja s 21 i više godina u službi. Ova razlika može se objasniti činjenicom da je nova generacija učenika odrasla uz tehnologiju i više joj se prilagodila. Lee i Tsai (2010) u svojem su istraživanju ustanovili značajne negativne korelacije između dužine radnoga staža učitelja i njihovih razina samoučinkovitosti u primjeni PMPS-a, što je rezultat sukladan rezultatima naše studije. Barış (2015) i Korucu (2017), u svom istraživanju s nastavnicima raznih predmeta, nisu pronašli značajne razlike s obzirom na dužinu radnoga staža, što je rezultat sukladan rezultatima ovoga istraživanja.

Prema varijabli mrežnoga iskustva, pronađena je značajna razlika u razinama percepcije samoučinkovitosti nastavnika prirodnih predmeta u odnosu na PMPS općenito i sve poddimenzije, osim poddimenzije mreža općenito. Rezultati pokazuju da su razine percepcije samoučinkovitosti nastavnika prirodnih predmeta koji koriste internet 10 ili više sati tjedno u odnosu na PMPS bile značajno više od onih koji koriste internet 0 - 3 sata ili 4 - 6 sati tjedno. Slični su rezultati istraživanja u literaturi (Yazar i Şimşek, 2015; Turan i Koç, 2016). Lee i Tsai (2010) pronašli su značajnu pozitivnu korelaciju između mrežnoga iskustva učitelja i razina samoučinkovitosti u korištenju PMPS-a. Stoga se može tvrditi da mrežno iskustvo učitelja ima značajan pozitivan utjecaj na njihove razine samoučinkovitosti u odnosu na PMPS.

Sudionici su naveli kako je njihovo poznavanje mrežnoga pedagoškog sadržaja imalo utjecaja, djelomičnog utjecaja ili nikakvog utjecaja na primjenu mrežno potpomognutoga poučavanja. Nastavnici koji su naveli da njihovo poznavanje mrežnoga pedagoškog sadržaja ima utjecaj na provođenje mrežnoga poučavanja objasnili su da je takva nastava sadašnji i budući trend u obrazovanju i da s višom razinom PMPS-a mogu pripremiti relevantan predmetni materijal te da imaju priliku pregledati aplikacije koje su razvili učitelji vješti u upotrebi mrežnoga alata. Canan Güngören i Horzum (2015) navode da poznavanje mrežnoga pedagoškog sadržaja budućih učitelja ima pozitivan učinak na upotrebu interneta u njihovoj budućoj profesiji. Štoviše, Zhou i sur. (2017) otkrili su da je poznavanje mrežnoga pedagoškog sadržaja nastavnika značajan prediktor njihove umješnosti u organizaciji *online* zadaća učenika. Ti rezultati su u skladu s rezultatima ove studije. Učitelji koji su izjavili da je poznavanje mrežnoga pedagoškog sadržaja imalo djelomičan utjecaj na primjenu mrežnoga poučavanja naglasili su da je mreža koristan alat poučavanja i da postoje brojni faktori koji utječu na poučavanje. Učitelji koji su izjavili da poznavanje mrežnoga pedagoškog sadržaja nema utjecaj na primjenu mrežnoga poučavanja izrazili su da nema potrebe za mrežnim poučavanjem, da su postojeći mrežni alati i aplikacije lagani za korištenje i da mreža nije važna za poučavanje.

Osim toga, istraživanje je pokazalo da su sudionici koristili mrežno poučavanje za raznolike svrhe poput predavanja, izvođenja eksperimenata, rješavanja problema, osiguravanja vizualne podrške, gledanja videa i nadoknađivanja nedostatnih materijala. Nadalje, nastavnici su izjavili da su izvodili eksperimente na mreži ili su pokazivali eksperimente izvedene na mreži jer im nedostaje laboratorij u njihovim školama, nemaju dovoljno materijala i zbog opasne prirode eksperimenata. Također su izjavili da su na taj način učenici bili aktivniji u rješavanju problema i da su razni problemi i testovi osnažili njihovu perspektivu. Znanost obuhvaća vizualne, dinamične i apstraktne sadržaje, a u njihovom prenošenju učenicima trebaju se osigurati primjereni materijali kako bi se ti sadržaji učinili razumljivijima (Kahyaoğlu, 2011). Nemogućnost predstavljanja svih materijala u učionici, uključujući skupe i teško pristupačne predmetne sadržaje, produbljuju potrebu za mrežnom nastavom. Stoga, mreža se može koristiti za vizualnu podršku i kompenzaciju nedostatnih materijala tijekom nastave. Nastavnici su se također osvrnuli na činjenicu da koriste mrežu kako bi prenijeli informacije predmetnoga sadržaja i podijelili videozapise eksperimenata s učenicima.

Nastavnici prirodnih predmeta u intervjuima spomenuli su pozitivne aspekte mrežnoga poučavanja poput lakoće pristupa informacijama, konkretizacije, vizualne podrške, uštede materijala i vremena, čestoga pregleda predmetne građe, motivacije za učenike i pomoći učenicima u stjecanju tehnoloških vještina. Uključivanje tehnologije u znanost i važnost tehnološke pismenosti u današnjem svijetu od učenika zahtijevaju stjecanje tehnoloških vještina. Çetin i sur. (2013) pokazali su da mrežno poučavanje razvija tehnološku pismenost. Područje usvajanja „informacija" u znanosti sastoji se od potpodručja živih bića i života, materije i promjene, fizičkih fenomena, kao i zemlje i svemira (MEB, 2013). Mreža je svakako korisna u poučavanju područja znanosti zato što osigurava pristup informacijama, konkretizaciju i vizualnu podršku.

Sudionici su navodili neke negativne aspekte mrežnoga poučavanja, poput narušavanja nastave, prethodne pripreme i navikavanja učenika da idu linijom manjeg otpora. Zamjetno je kako te negativne aspekte uzrokuju učitelji ili učenici, a čini se da bi ih učitelji mogli ukloniti.

Nastavnici su ukazali na sljedeće probleme u mrežnom poučavanju: tehnički problemi i narušen red u učionici, prekidi internetske veze, nedovoljna tehnička oprema i blokirane mrežne stranice. Odluka o blokiranju pojedinih mrežnih stranica od strane turskog Ministarstva obrazovanja mogla bi se ponovo razmotriti kako bi se dopustio pristup nekima od njih, potencijalno korisnima za nastavnike. Oni bi nadležnim vlastima trebali navesti koje su to stranice i na taj način pridonijeti eliminaciji ovoga problema. Narušavanje razredne discipline, koje je navedeno kao jedan od negativnih aspekata, mogu spriječiti sami učitelji.

Rezultati pokazuju da su nastavnici najvažniji faktor koji utječe na mrežno potpomognuto poučavanje. Razine samoučinkovitosti sudionika u mrežnoj nastavi i suradnja s kolegama igraju učinkovitu ulogu u primjeni mrežne nastave. Pristup internetu i veličina razreda smatraju se aspektima infrastrukture. Nastavnici su izjavili da doživljavaju prekide internetske veze u školama izvan centra i da učitelji informatike u školama imaju važnu ulogu u mrežno potpomognutoj nastavi.

Prijedlozi

U školama se mogu napraviti tehnička poboljšanja nužna za mrežno poučavanje. Obrazovne mrežne stranice mogu se usavršiti u smislu kvalitete i kvantitete. Moguće je dizajnirati učinkovitije mrežne alate ili aplikacije o predmetnom sadržaju u suradnji s učiteljima i stručnjacima za programsku podršku.

Predlažemo provođenje eksperimentalnih studija radi promatranja promjena u poznavanju mrežnoga pedagoškog sadržaja nastavnika. Buduća istraživanja mogu elaborirati faktore koji utječu na razinu percepcija samoučinkovitosti nastavnika i njihovo poznavanje mrežnoga pedagoškog sadržaja.