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European Teachers' Technological Pedagogical Content Knowledge (TPCK) and Educational Use of Web Technologies

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Abstract: Several studies have been conducted on technological, pedagogical content knowledge and web-based education. In this study, the Technological Pedagogical Content Knowledge and Educational Use of Web Technologies (TPCK-W) were analyzed in addition to the self-efficacy and attitudes of 33 teachers from eight different branches carrying out their duties in 19 countries of the European Union (EU). In this study, the Technological Pedagogical Content Knowledge-Web (TPCK-W) Survey developed by Lee, Tsai, and Chan was used. The data obtained statistics software was analyzed using SPSS for Windows 17.0 statistics software. As a result of the analysis, it was revealed that TPCK-W self-efficacy of teachers carrying out their duties in EU countries was high and their attitudes were positive; and age, experience, and gender did not affect their TPCK-W self-efficacy and attitudes. Moreover, participants' general web attitudes changed positively, depending on their web communication, web content, and pedagogical use of the web.

Keywords: *Technological pedagogical content knowledge, TPCK-W, AB TPCK-W, EU TPCK-W, TPCK-W self-efficacy.*

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Introduction

The Internet has become one of the most indispensable aspects of education, as in many other areas of life. Due to this, the WWW technologies, or, in other words, "web technologies," have come to be frequently used in educational fields.

Since the new generation has witnessed the development of technology, they adapt to new devices and applications easily, while the ones above a certain age have difficulty in adapting to this change despite their sincere attempts. Individuals rendering service in educational fields have also shown efforts in adapting to new educational technologies that have emerged through the integration of pedagogical content with technology, and in using these educational technologies in their lessons. Educational technologies have shown a rapid change in recent years and become more web-based; and the obligation for educationalists to learn and use web technologies together with educational technologies has emerged very strongly.

Countries having and using Information and Communication Technologies (ICTs) determine them being an "Information Society," and this can be considered as an indicator of their using ICT for educational purposes. In the context of developing

countries, ICTs have the potential to overcome economic problems, depending upon investment in ICTs. When the 2010 and 2011 data of the ICTs Development Index (ICT Development Index-IDI) was published, it drew attention to the fact that South Korea was at the top; however, during the same years, EU countries have been most frequently listed among the first 40 ranks of the ICT Development Index (<http://www.trakya2023.com/>, 2013). When the ratios of home users in countries ranking among the first 10 ranks of the ICT Development Index for having a computer and internet access were analyzed, it was noticed that both ratios were over 80% (Figure 1). When considered from this point of view, it must be accepted that it is indispensable to use web-based technologies in any environment where computers and the Internet are used so commonly.

Several studies have been conducted to reveal the attitudes and to determine the self-efficacy and attitudes of individuals, together with the web-based technologies becoming indispensable in education. In recent years, especially, several studies related to the use of web-based technological and pedagogical content knowledge (TPCK-W) have been conducted. The Technological Pedagogical Content Knowledge (TPACK) scale, developed by Mishra and Koehler

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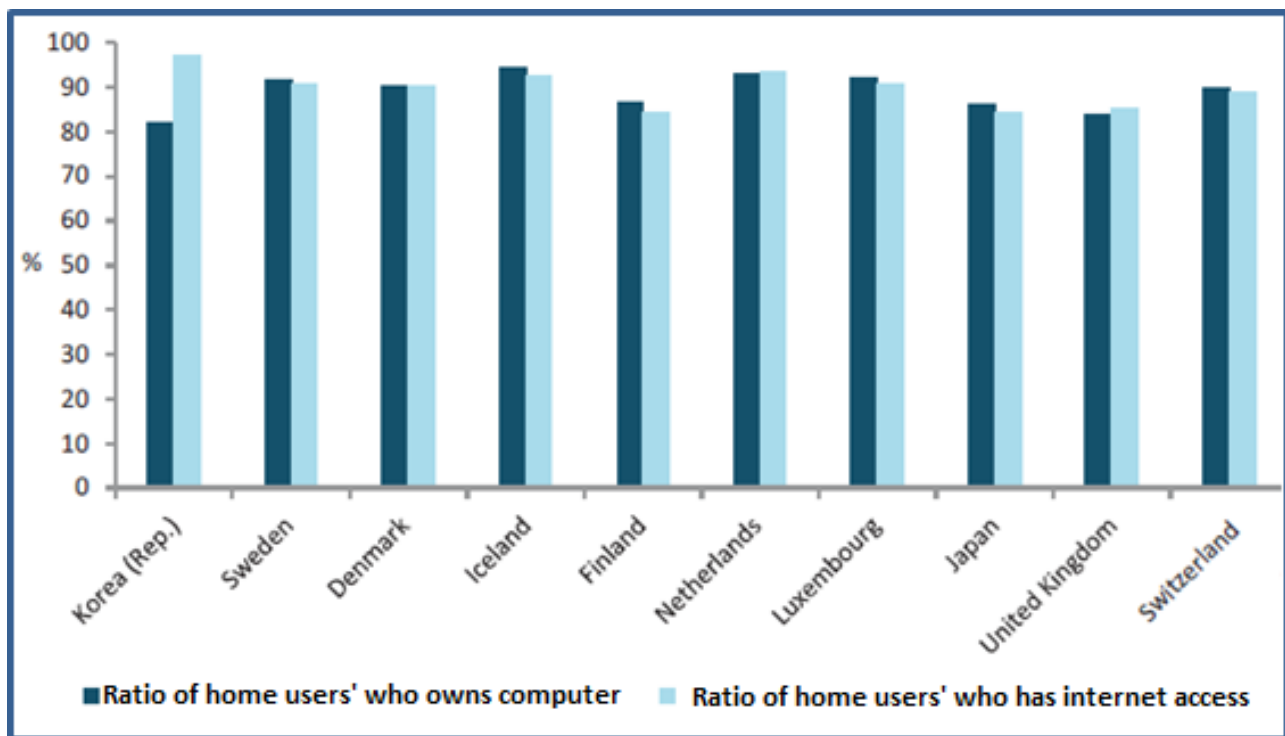


Figure 1 The ratio of home users in the first 10 ranks of the ICT Development Index for having a computer and internet access (United Nations Publication, 2012)

(2006), and the Technological Pedagogical Content Knowledge-Web (TPCK-W), developed by Lee and Tsai (2008), are the ones that have been most frequently used in the literature. Horzum and Gungoren (2012) researched web-based Instruction (WBI) beliefs, acceptance of WBI tools, and WPCK of pre-service teachers in 2012. Agyei and Voogt (2012) carried out a study to show the potential of TPACK as a new framework for developing pre-service teachers' experiences in technology integration within initial teacher education, particularly in Sub-Saharan African countries. In another study, the factors that prevent educators from using ICTs in their pedagogy were analyzed (Chigona & Chigona, 2010). Horzum (2012) conducted a study on determining the effects of web-based instruction on students' web pedagogical content knowledge. A study conducted in South Africa aimed to understand the pedagogical use of ICTs in schools in 22 education systems (Blignaut et al., 2008). Chuang and Ho (2011) aimed to investigate the technological pedagogical content knowledge (TPCAK) of early childhood teachers in Taiwan. In a study carried out in 2011, the TPCA framework was used in order to understand what kind of an attitude the pre-service teachers displayed related to the use of ICTs (Graham et al., 2011). Semiz and Ince (2012) aimed to identify the TPACK of their university lecturers. It was aimed at demonstrating the undesirability of an unnatural separation of ICTs from teaching and learning in dominant discourses within institutional and national environments (Mostert & Quinn, 2009). The theoretical construction, statistical validity, and reliability of a survey instrument designed to measure the TPCA of teachers were described (Albion et al., 2010). Kaya and

her friends (2011) aimed at exploring pre-service information technology teachers' perception of self-efficacy in web-technological pedagogical content knowledge (Web-TPACK). Lee and Tsai (2010) provided a framework for understanding teachers' Technological Pedagogical Content Knowledge-Web (TPCAK-W) while integrating web technology into their pedagogical practice. Yurdakul (2011) carried out a study in order to determine pre-service teachers' techno-pedagogical knowledge competencies and to examine the differences between those competencies and the level of using the ICT. In another study, it was mentioned that the TPACK scale has been a valuable tool for researchers to reveal the TPACK development of teachers and pre-service teachers (Baran et al., 2011). Sahin (2011), in his study, proved that the TPACK scale has been an appropriate and reliable tool.

Methodology

Research Goal

The purpose of this study is to measure the attitudes of teachers carrying out their duties in EU countries toward web-based education and their self-efficacy in technological and pedagogical content knowledge. As result of the study, the answers to the questions below were sought:

- 1) What are the TPCK-W self-efficacy levels of teachers carrying out their duties in EU member countries?
- 2) Do the TPCK-W levels of teachers carrying out their duties in EU member countries differ according to age, experience, and gender?

3) Is there a relation between the participants' general web knowledge and their web communication, content, and pedagogical content knowledge?

4) Is there a relation between the general web knowledge of the participants and their attitudes toward web-based education?

Sample and Data Collection

The study group of the research included teachers carrying out their duties in elementary and secondary education schools of EU countries. This group included the people whom the researcher met at EU Lifelong Learning Program's in-service training courses, contact seminars, and study visits he attended in Finland in 2006, in Slovenia in 2007, Lithuania and Estonia in 2008, in Czech Republic in 2009, and in Italy in 2012 and 2013. Within this context, 18 people were contacted as face-to-face respondents and 99 people through e-mail. Totally, 117 people were asked to participate in the study. As a result, a total of 33 people from 19 different countries, including Belgium (3); Portugal (3); Romania (2); Luxembourg (2); United Kingdom (2); Poland (1); Turkey (4); Estonia (2); France (1); Finland (1); Greece (3); Slovenia (1); Spain (2); Czech Republic (1); Norway (1); Hungary (1); Croatia (1); Sweden (1); and the Netherlands (1), participated in this study. This proved that 28.2% (117) of the targeted people participated into this study. The participants were 18 female (54.5%) and 15 male (45.5%) (Table 1).

Table 1. Distribution of participants according to gender

| Gender | N | f (%) |
|--------|----|-------|
| Female | 18 | 54,55 |
| Male | 15 | 45,45 |

The age variable of the participants was 4 (12.12%) between 21–27 years old, 10 (30.30%) between 28–35 years old, 8 (24.24%) between 36–43 years old, 8 (24.24%) between 44–55 years old, and 3 (9.1%) for over 55 years old (Table 2); while the variable of teaching experience showed a distribution of 6 (18.18%) between 1–7 years, 14 (42.42%) between 8–15 years, 10 (30.30%) between 16–25 years, and 3 (9.1%) for over 25 years (Table 3). Teachers from the departments of Mathematics, IT, Physics, Literature, Foreign Language, Chemistry, History, and Geography participated in this study.

Table 2. Distribution of participants according to age

| Age Group | N | f (%) |
|-----------|----|-------|
| 21-27 | 4 | 12,12 |
| 28-35 | 10 | 30,30 |
| 36-43 | 8 | 24,24 |
| 44-55 | 8 | 24,24 |
| Over 55 | 3 | 9,10 |

Table 3. Distribution of participants according to teaching experience

| Teaching Experience | N | f (%) |
|---------------------|----|-------|
| 1-7 years | 6 | 18,18 |
| 8-15 years | 14 | 42,42 |
| 16-25 years | 10 | 30,30 |
| Over 25 years | 3 | 9,10 |

In this study, the TPCK-W Survey was used. This survey was developed by Lee, Tsai and Chang (2008) to assess teachers' self-efficacy in terms of web pedagogical content knowledge. The TPCK-W survey was created with a TPCK-W framework, including Web knowledge (WK), Web-Content knowledge (WCK), Web-Pedagogical knowledge (WPK), and Web-Pedagogical-Content knowledge (WPCK). The five-point Likert scale included 5 factors consisting of 30 items. These factors were "web general," including 7 items, "web communication," including 4 items, "web content knowledge," including 5 items, "web pedagogical content knowledge," including 8 items, and "the attitude toward web-based instruction," including 6 items.

Analysis of Data

The self-efficacy and attitude survey used in this study was transferred to web using Google survey tool, and sent to the participants in English. The participants accessed and filled in the survey using the link in their e-mail addresses. The data obtained in this study were analyzed using SPSS (Statistical Package for Social Sciences) for Windows 17.0 program. While evaluating the data, descriptive statistical methods (Number, Percentage, Average, Standard deviation) were used. For the comparison of quantitative data, Mann-Whitney U-Test was used for the difference between the two groups, and Kruskal-Wallis Test was used for the intergroup comparison of the parameters in case of more than two groups. Spearman correlation analysis was performed among the variables of this study.

The obtained findings were evaluated at 95% confidence interval, and 5% level of significance.

Findings/Results

In this section, the findings obtained as a result of the data collected through the scales from this study participants were included. Explanations and suggestions were offered, based upon the obtained findings.

Table 4. Self-Efficacy levels

| | N | Av. | SD | Min. | Max. |
|--|----|------|-------|------|------|
| Web-general | 33 | 4,75 | 0,380 | 4,00 | 5,00 |
| Web-communicative | 33 | 4,06 | 0,852 | 1,75 | 5,00 |
| Web-content | 33 | 4,25 | 0,641 | 3,00 | 5,00 |
| Web-pedagogical-content | 33 | 3,90 | 0,918 | 1,38 | 5,00 |
| Attitudes Toward Web-based Instruction | 33 | 4,37 | 0,515 | 3,33 | 5,00 |

Table 5. Analysis of Kruskal Wallis H-Test– Averages of self-efficacy levels according to the variable of “age”

| | Group | N | Av. | SD | KW | p |
|--|--------------|----|-------|-------|-------|-------|
| Web-general | 21-27 Ages | 4 | 4,500 | 0,577 | 3,161 | 0,531 |
| | 28-35 Ages | 10 | 4,686 | 0,403 | | |
| | 36-43 Ages | 8 | 4,839 | 0,354 | | |
| | 44-55 Ages | 8 | 4,893 | 0,213 | | |
| | Over 55 Ages | 3 | 4,667 | 0,459 | | |
| Web-communicative | 21-27 Ages | 4 | 4,375 | 0,433 | 5,441 | 0,245 |
| | 28-35 Ages | 10 | 4,225 | 0,946 | | |
| | 36-43 Ages | 8 | 4,094 | 0,767 | | |
| | 44-55 Ages | 8 | 4,094 | 0,731 | | |
| | Over 55 Ages | 3 | 2,917 | 1,041 | | |
| Web-content | 21-27 Ages | 4 | 3,900 | 0,683 | 4,516 | 0,341 |
| | 28-35 Ages | 10 | 4,240 | 0,430 | | |
| | 36-43 Ages | 8 | 4,150 | 0,791 | | |
| | 44-55 Ages | 8 | 4,650 | 0,487 | | |
| | Over 55 Ages | 3 | 4,000 | 1,000 | | |
| Web-pedagogical-content | 21-27 Ages | 4 | 3,125 | 0,974 | 4,758 | 0,313 |
| | 28-35 Ages | 10 | 3,925 | 0,888 | | |
| | 36-43 Ages | 8 | 3,875 | 1,171 | | |
| | 44-55 Ages | 8 | 4,250 | 0,539 | | |
| | Over 55 Ages | 3 | 4,000 | 1,000 | | |
| Attitudes Toward Web-based Instruction | 21-27 Ages | 4 | 3,708 | 0,534 | 5,784 | 0,216 |
| | 28-35 Ages | 10 | 4,400 | 0,439 | | |
| | 36-43 Ages | 8 | 4,542 | 0,596 | | |
| | 44-55 Ages | 8 | 4,438 | 0,308 | | |
| | Over 55 Ages | 3 | 4,500 | 0,577 | | |

The “web-general” level of the participants was determined as very high ($4,749 \pm 0,380$); “web communication” level as high ($4,061 \pm 0,852$); “web-content” level as very high ($4,255 \pm 0,641$); “web-pedagogical-content” level as high ($3,902 \pm 0,918$); and “attitudes toward web-based instruction” level was also determined as very high ($4,369 \pm 0,515$) (Table 4).

According to the results of the Kruskal Wallis H-test performed to determine whether the web-general, web-communicative, web-content, web-pedagogical-content, attitudes toward web-based instruction score averages of the participants differ in terms of the Age variable, the difference between the group averages was not found to be significant ($p > 0,05$) (Table 5).

Table 6. Analysis of Kruskal Wallis H-test– Averages of self-efficacy levels according to the variable of “teaching experience”

| | Group | N | Av | SD | KW | p |
|--|---------------|----|-------|-------|-------|-------|
| Web-general | 1-7 Years | 6 | 4,667 | 0,516 | 0,543 | 0,909 |
| | 8-15 Years | 14 | 4,776 | 0,366 | | |
| | 16-25 Years | 10 | 4,786 | 0,338 | | |
| | Over 25 Years | 3 | 4,667 | 0,459 | | |
| Web-communicative | 1-7 Years | 6 | 4,500 | 0,418 | 5,898 | 0,117 |
| | 8-15 Years | 14 | 4,018 | 0,963 | | |
| | 16-25 Years | 10 | 4,200 | 0,563 | | |
| | Over 25 Years | 3 | 2,917 | 1,041 | | |
| Web-content | 1-7 Years | 6 | 4,033 | 0,599 | 1,789 | 0,617 |
| | 8-15 Years | 14 | 4,343 | 0,605 | | |
| | 16-25 Years | 10 | 4,340 | 0,660 | | |
| | Over 25 Years | 3 | 4,000 | 1,000 | | |
| Web-pedagogical-content | 1-7 Years | 6 | 3,458 | 0,917 | 3,034 | 0,386 |
| | 8-15 Years | 14 | 3,839 | 1,123 | | |
| | 16-25 Years | 10 | 4,225 | 0,482 | | |
| | Over 25 Years | 3 | 4,000 | 1,000 | | |
| Attitudes Toward Web-based Instruction | 1-7 Years | 6 | 3,972 | 0,662 | 3,068 | 0,381 |
| | 8-15 Years | 14 | 4,476 | 0,506 | | |
| | 16-25 Years | 10 | 4,417 | 0,354 | | |
| | Over 25 Years | 3 | 4,500 | 0,577 | | |

Table 7. Analysis of Kruskal Wallis H-test– Averages of self-efficacy levels according to the variable of “gender”

| | Group | N | Av | SD | MW | p |
|--|--------|----|-------|-------|---------|-------|
| Web-general | Female | 18 | 4,770 | 0,377 | 132,500 | 0,918 |
| | Male | 15 | 4,724 | 0,395 | | |
| Web-communicative | Female | 18 | 4,139 | 0,763 | 123,500 | 0,675 |
| | Male | 15 | 3,967 | 0,968 | | |
| Web-content | Female | 18 | 4,211 | 0,721 | 125,500 | 0,726 |
| | Male | 15 | 4,307 | 0,550 | | |
| Web-pedagogical-content | Female | 18 | 3,813 | 1,131 | 132,500 | 0,927 |
| | Male | 15 | 4,008 | 0,595 | | |
| Attitudes Toward Web-based Instruction | Female | 18 | 4,250 | 0,567 | 101,500 | 0,221 |
| | Male | 15 | 4,511 | 0,420 | | |

Table 8. Correlation table of relation between the self-efficacy levels

| | r | W | WC | W-Con | WPC | WBI |
|--|---|---------|-------|---------|---------|-------|
| Web-general (W) | r | 1,000 | | | | |
| Web-communicative (WC) | r | 0,382* | 1,000 | | | |
| Web-content (W-Con) | r | 0,658** | 0,253 | 1,000 | | |
| Web-pedagogical-content (WPC) | r | 0,411* | 0,040 | 0,688** | 1,000 | |
| Attitudes Toward Web-based Instruction (WBI) | r | 0,524** | 0,177 | 0,638** | 0,591** | 1,000 |

(* $p < 0.05$, ** $p < 0.01$: especially 0.01 level of significance means found correlation is significant and is not coincidental)

According to the results of the Kruskal Wallis H-test performed to determine whether the web-general, web-communicative, web-content, web-pedagogical-content, attitudes toward web-based instruction score averages of the participants differ in terms of the teaching experience variable, the difference between the group averages was not found to be significant ($p > 0.05$) (Table 6).

According to the results of the Mann-Whitney U-test performed to determine whether the web-general, web-communicative, web-content, web-pedagogical-content, attitudes toward web-based instruction score averages of the participants differ in terms of the teaching experience variable, the difference between the group averages was not found to be statistically significant ($p > 0,05$) (Table 7).

The Spearman correlation analysis was performed to see if the factors of self-efficacy levels affect or are related to each other. It was aimed to see if there is a relation between the participants' general web knowledge and their web communication, content, and pedagogical content knowledge. A statistically significant relation was found between “web-communicative” and “web-general” ($r = 0.382$; $p = 0,028 < 0.05$), between “web-content” and “web-general” ($r = 0.658$; $p = 0,000 < 0.05$), between “web-pedagogical-content” and “web-general” ($r = 0.411$; $p = 0,017 < 0.05$) and between “attitudes toward web-based instruction” and “web-general” ($r = 0.524$; $p = 0,002 < 0.05$). Accordingly, as the “web-communicative,” “web-content,” “web-pedagogical-content,” “attitudes toward web-based instruction” increased, the “web-general” increased, as well (Table 8). According to these results, it can be said that general web abilities affect communication, content

and pedagogical content knowledge, and attitudes toward web-based instruction positively.

Also, the relation between the general web knowledge of the participants and their attitudes toward web-based education is analyzed. A statistically significant relation was found between “web-pedagogical-content” and “web-content” ($r = 0.688$; $p = 0,000 < 0.05$) and between “attitudes toward web-based instruction” and “web-content” ($r = 0.638$; $p = 0,000 < 0.05$). Accordingly, as the “web-pedagogical-content” and “attitudes toward web-based instruction” increased, the “web-content” increased, as well. A statistically significant relation was found between “attitudes toward web-based instruction” and “web-pedagogical-content” ($r = 0.591$; $p = 0,000 < 0.05$). It has been noted that there were no statistically significant relation between the “web-content” and “web-communicative,” between “web-pedagogical-content” and “web-communicative,” and between “attitudes toward web-based instruction” and “web-communicative” ($p > 0.05$) (Table 8).

Discussion and Conclusion

TPACK has become one of the most important indicators to measure the efficacy levels of educators in recent years. In this study, we tried to determine the self-efficacy perceptions and the attitudes of teachers from different countries of the EU toward web-based education in terms of web-based technological pedagogical content knowledge. Participants from 19 of the 28 European Union countries were included in this study. In previous years, studies have been conducted, which analyzed the teachers, pre-service teachers, and students from the Faculty of Education in terms of technological pedagogical content knowledge.

Creating a fair technological opportunity for everyone by removing restrictions of region, education, and economic status through public access to ICT is key to rectifying the digital divide, particularly as e-tutoring has increasingly become a cost-effective technique for providing remedial support to improve school children's academic achievements (Chuang, 2013). It was emphasized in a study that South Africa's inability to cross the boundaries of traditional learning toward the development of 21st-century teaching and learning skills inhibits social and economic growth for the development of human capital (Blignaut et al., 2010).

In the literature, the results obtained through the researches carried out on technological pedagogical content knowledge of individuals were as follows: Lee and Tsai (2005) found similar results of the TPCK-W survey as those found in this study; teachers in Taiwan expressed a relatively high self-efficacy in terms of their general use of the web. The study carried out by Mostert and Quinns (2009) was concluded by highlighting some implications of the TPACK framework for staff developers and curriculum design in higher education. Horzum (2012) showed that the WPCK and attitudes toward WBI did not differ between the experiment and control groups before the experimental procedure. Researchers found that experienced teachers' knowledge self-efficacy is higher than that of junior teachers. It was identified that the teaching experience was the major source of developing PCK. However, it was also found that junior teachers were more successful in using PCK with technology and presenting it as web-based (Lee and Tsai, 2010). It was revealed that for effective use of technology in the classrooms, the educators need to be equipped with TPACK (Chigona & Chigona, 2010). At the end of the study carried out by Blignaut et al. (2010), a large percentage of South African teachers reported their ICT incompetence. According to another study, the analyses showed that most pre-service teachers had high levels of self-efficacy in Web-TPACK. It was found that there was no significant difference in pre-service teachers' self-efficacy in Web-TPACK in terms of their gender, except from the sub-scale of Web-communication (Kaya et al., 2011). Yurdakul (2011) showed that, in general, ICT usage level of pre-service teachers depends on their techno-pedagogical knowledge competencies, and pre-service teachers in the study had high level techno-pedagogical knowledge competency. It was also found that more systematic efforts have been needed to engage pre-service teachers in technology-rich design activities, and to develop their TPACK adequately (Agyei and Voogt, 2012). As seen in this study, similar results were obtained as in the previous ones.

In some studies, the TPCK-W self-efficacy levels of the participants were found to be different; however, in this study, self-efficacy levels of the participants were found to be at a close level, not depending upon age, experience, and gender. Very high and high self-efficacy levels of the teachers participating in this study from different countries of the EU can be considered as an

indicator of EU countries' use of ICT commonly in education. Moreover, ICT usage levels of the teachers participating in EU education programs were high, and depending upon this, their level of using WWW technologies in education was also considered to be high.

No significant difference between the group averages of participants' TPCK-W self-efficacy and attitudes in terms of age, experience, and gender revealed that TPCK-W self-efficacy and attitudes of participants were at a close level, without considering age, gender, and experience. Based on this, it can be said that the teachers in EU countries have positive attitudes and high TPCK-W self-efficacy levels, in general.

No significant difference between "web general" and "web-communicative," "web-content," "web-pedagogical-content," and "attitudes toward web-based instruction" factors revealed that the attitude of participants toward web communication, content, pedagogical content use, and web-based education was directly proportional to general web technologies self-efficacy.

The significant difference between "web-content," "attitudes toward web-based instruction," and "web-pedagogical-content" factors revealed that the web content use and pedagogical web content self-efficacy of participants was directly proportional to their attitudes toward web-based education.

As result of this study, it was revealed that TPCK-W self-efficacy of the teachers carrying out their duties in different EU countries was high and their attitudes were positive. Upon this, further research can be carried out to make comparisons among the EU countries as well as among EU countries and other countries. A framework program can be prepared and TPCK-W self-efficacy and attitudes of teachers can be measured through the pre- and post-tests, and the effect of the applied framework upon TPCK-W self-efficacy levels and attitudes of teachers can be analyzed.

Notes

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