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Examining EFL Teachers' Perceptions of Technological Pedagogical Content Knowledge and Web 2.0 Technologies Using a Structural Equation Modeling Technique

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ABSTRACT

Technological pedagogical content knowledge (TPACK) provides a framework of teacher knowledge to integrate technology into education successfully. Applying digital technologies to TPACK in order to understand the range of language teachers' ability levels is of considerable importance. The present study sought to examine Iranian EFL teachers' perceived knowledge of Web 2.0 technologies in light of Mishra and Koehler's (2006) TPACK framework. To this end, a structural model was put forth on the basis of interactions of the TPACK seven-factor model. The participants of the study consisted of 160 EFL teachers, who were selected through an alternative sampling procedure. The data were collected from the participants through a TPACK-EFL questionnaire. The structural equation modeling (SEM) technique was employed to analyze the pathways of Web 2.0 technology, pedagogy, and content and their interactions in the TPACK model. The results revealed that Web 2.0 technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK), as core knowledge components, influenced the second-level knowledge bases, namely technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK), and technological content knowledge (TCK) positively and directly except for one construct. Conversely, the impacts of TK, PK, and CK on TPACK were not statistically significant, and, as a result, did not work towards developing EFL teachers' TPACK. Furthermore, TPK, TCK, and PCK were found to serve as contributing factors in the development of TPACK. Finally, the pedagogical and theoretical implications of interrelationships between the constructs and possible interpretations are discussed.

Keywords: Structural Equation Modeling (SEM), Technological Pedagogical Content Knowledge (TPACK), Web 2.0 Technologies

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1. Introduction

Web 2.0 technologies have turned into an omnipresent phenomenon in people's everyday lives almost all over the world. Web 2.0 specifically includes social networking applications and websites, instant messaging, wikis, weblogs, file-sharing services, podcasts, etc. Web 2.0 devices allow collaboration, knowledge sharing and networking activities on a social platform (Davies et al., 2013). These technologies are gathering momentum in education due to learners' need to build new skills and gain educational attainment at the beginning of the 21st century (Sadaf et al., 2016; Teo et al., 2019). Moreover, the emergence of Web 2.0 technologies has offered excellent potential for integrating new applications into teaching and learning of all English language skills and components (Chapelle & Sauro, 2017; Tzotzou, 2018). Thus, Web 2.0 technological devices have provided computer-assisted language learning (CALL) with digital affordances to facilitate the task of language learning and teaching (Parmaxi & Zaphiris, 2017; Wang & Vásquez, 2012). The widespread utilization of Web 2.0 technologies in language education settings compels EFL practitioners to know how to infuse digital technologies into the teaching process.

There is a substantial body of literature that recognizes the importance of teacher knowledge in implementing technology. TPACK is one influential framework in educational technology (Mishra & Koehler, 2006) which has been introduced to examine teachers' competence in terms of integrating technology for pedagogical purposes. TPACK rests upon three main bodies of competencies called, technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK) for successful technology integration. There are four other knowledge components including technological pedagogical knowledge (TPK), technological content knowledge (TCK) and pedagogical content knowledge (PCK) which are formed by making interconnections among the first three knowledge bases and finally the TPACK as the intersecting and main element of the framework.

TPACK has been widely acclaimed by many scholars in education and several studies have been done over the last 15 years, most of which have focused on general TPACK knowledge (e.g., Akkaya, 2016; Arslan, 2015; Deng et al., 2017; Jang & Tsai, 2013; Khine et al., 2019; Koh, 2013; Koh & Divaharan, 2013; Liu & Kleinsasser, 2015; Miguel-Revilla et al., 2020; Rahimi & Pourshahbaz, 2016; Zhang et al., 2019). Research has revealed that the level of technological, pedagogical and content knowledge associated with English instruction in EFL classes is not satisfactory (Raygan & Moradkhani, 2020; Taghizadeh & Hasani Yourdshahi, 2020). Meanwhile, it is not known how Iranian EFL teachers perceive their TPACK when they used Web 2.0 technologies. Moreover, most of the studies on EFL teachers'

TPACK have neglected to examine the interactions between factors of the TPACK model, particularly how the connections work towards teachers' trajectories to technological pedagogical content knowledge (Habibi et al., 2020). There has been less research into TPACK and Web 2.0 technologies in EFL contexts by proposing structural relationships to examine the direct and positive impacts of TK, PK, CK on TCK, TPK, PCK, and TPACK. This indicates the need to understand the perceptions of EFL teachers regarding what pathways they go through in integrating TPACK of Web 2.0 into EFL teaching.

The current study sought to examine Iranian EFL teachers' perceptions by testing a structural model to analyze the pathways of Web 2.0 technology, pedagogy, and content and their interactions in light of Mishra & Koehler's (2006) TPACK theoretical framework. Therefore, the primary purpose of this study was to gain an understanding of EFL teachers' range of Web 2.0 technological, pedagogical, and content knowledge domains through structural equation modeling. With this intention in mind, it seems imperative to explore EFL teachers' knowledge of teaching with Web 2.0 technologies and through this, researchers will be informed about knowledge sources they require to integrate Web 2.0 technologies into EFL teaching. Accordingly, the present study aimed at answering the following research question:

> What are the possible trajectories perceived by EFL teachers towards TPACK of Web 2.0 technologies?

2. Literature Review

2.1. TPACK Framework

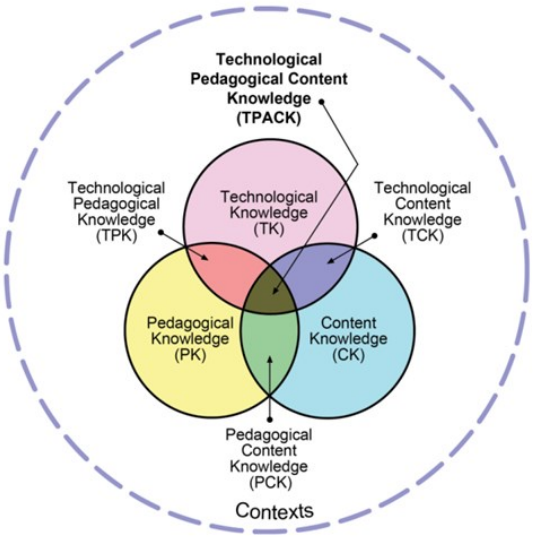
Mishra & Koehler (2006) extended Shulman's (1986; 1987) pedagogy-content dual knowledge by incorporating the technology aspect into the model referred to as technological, pedagogical, and content knowledge, briefly known as the TPACK. In the TPACK model (see Figure 1) three main components of teacher knowledge, namely technology, pedagogy, and content are recognized. The intersections of these knowledge forms give rise to second-level knowledge structures, identified as TPK (technological pedagogical knowledge), PCK (pedagogical content knowledge), TCK (technological content knowledge), and the TPACK (Koehler et al., 2014).

In advance of Mishra and Koehler's (2006) introduction of the TPACK theoretical framework, the field of education suffered a major setback regarding how to understand what knowledge systems teachers needed to overcome the relative lack of integrating technological knowledge into teaching (Koh et al., 2013). Mishra & Koehler's (2006) conceptualization of TPACK paved the way to fill the void by providing a

theoretical basis to clarify different sorts of knowledge teachers require to blend technology into instruction. Since then, a wealth of research on TPACK has corroborated its applicability and practicality in evaluating teacher knowledge (e.g., Celik et al., 2014; Chai et al., 2011; Khine et al., 2019; Kiray et al., 2018; Koh et al., 2013, Njiku et al., 2020; Valtonen et al., 2019). Accordingly, the world of educational technology will doubtless witness investigations into the TPACK framework continuously aiming at integrating more innovative and interactive digital devices into teaching practice in prospect.

Figure 1

Technological Pedagogical Content Knowledge (TPACK) Model Adapted from www.tpack.org



2.2. Research on Teachers' TPACK in Educational Contexts

The TPACK framework has been applied to examine pre-service or in-service teacher knowledge in EFL settings (Ekrem & Recep, 2014; Kurt et al., 2013; Rahimi & Pourshahbaz, 2016). However, none of these studies have taken account of causal relationships that might exist among different constructs leading to the main product of the framework that is the TPACK. As clarified by Mishra & Koehler (2006), two possible trajectories to Technological Pedagogical Content Knowledge (TPACK) could be conceived. One trajectory concentrates on the direct effect of TK, CK, and PK while the second one considers the effects of intervening knowledge components of TCK, TPK, and PCK. Owing to the nature of TPACK framework, the focus of studies has been on pre-service teachers in general educational contexts and several content areas.

In one of the earliest studies on the issue, Chai et al. (2011) modeled Singaporean elementary school pre-service teachers' TPACK for meaningful learning through structural path analyses. The research involved collecting data from a newly-constructed TPACK survey which was particularly designed for a 12-week ICT teacher training course. It was indicated that PK influenced TPACK directly as the course started. When teachers made links between their TK and PK leading to TPK throughout the course, the direct relationship between PK and TPACK did not become significant, but the associations between PK and TPK, and TPK and TPACK became stronger. Meanwhile, a pre-post comparison of the course models uncovered that the teachers' perceptions regarding the relationship between CK and TPACK became significant. A recent systematic literature review by Wang et al. (2018) concluded that modeling of technology use in ICT courses is of utmost importance in teachers' TPACK development. TPACK was also used to integrate cyberwellness knowledge in designing web-related learning in a pre-post ICT course (Chai et al., 2012). Two surveys were handed out and as a result, five TPACK constructs (PK, CK, Web 2.0 TK, TPK, TPACK) were extracted from running factor analysis. The results of the pre-post course questionnaires showed that the teachers improved much in 5 out of 6 TPACK factors. In a follow-up inquiry, Chai et al. (2013) studied 550 pre-service teachers' seven-factor TPACK model. The results of statistical analyses supported eight hypothesized relationships out of 12 hypotheses between TPACK factors. The findings further depicted that CK, PK, and TK did not have any positive and directs effects on TPACK. Moreover, the effect of CK on PCK was not supported either. The rest of all possible relationships were corroborated.

Among other modeling TPACK investigations into the direct and positive cross-effects of basic and intermediary knowledge domains including CK, PK, TK, TPK, TCK, and PCK on TPACK, Koh et al. (2013) reported that TK and PK influenced TPACK directly and positively. Furthermore, they contributed to the formation of TPK and TCK, which in turn brought about the development of practicing teachers' TPACK. Yet, CK and PCK did not exert any influences on the teachers' TPACK. Lin et al.'s (2013) study revealed that the teachers' TPACK strongly correlated with their TCK, TPK, and TK. The findings supported the seven constructs of TPACK and showcased that the teachers' perceptions of the techno-pedagogy-content trilogy were highly correlated with all of the TPACK variables. Likewise, Pamuk et al. (2013) demonstrated that nine out of 12 impacts among the seven elements of TPACK were statistically significant except for the positive effects of TK, CK, and PK on TPACK. Also, the effects of TPK and TCK were strong determinants of explaining the TPACK variance. Additionally, the intermediary constructs including TPK, TCK,

PCK had stronger influences on predicting TPACK construction than TK, CK, and PK. A related study by Yang et al. (2019) exploring the effect of teachers' level of TPACK on the adoption of E-schoolbag indicated that there were significant interconnections among the TPACK constructs except for the association between PCK and TPACK.

In one the latest developments, Schmid et al. (2020) constructed a short-scale TPACK measure in order to examine Swiss pre-service teachers' areas of knowledge sources in a training course. It was shown that TK, PK, and CK did not affect TPACK directly. In contrast, TK affected TPK and TCK; PK affected TPK and PCK; CK influenced TCK and PCK significantly. TPK and PCK influenced TPACK directly but TCK did not. In a modeling study on the sense of efficacy and TPACK among Turkish chemistry teachers, Sen (2020) illustrated that CK, TK, and PCK influenced TPACK directly and positively. It was concluded that the increase in TPACK depends on TK, CK, and PCK.

In some recent modeling research studies, the role of TCK to predict TPACK was not considered including Khine et al. (2017) who examined Emirati pre-service teachers' perceived relations of TPACK factors. The research results indicated that TK impacted significantly upon TPK and TPACK. PK affected TPK, TPACK, and PCK significantly. Moreover, CK affected TPACK significantly but there was no causal relationship between CK and PCK. TPK and TPACK were related significantly but there was no association between PCK and TPACK. Their research is complemented by Khine et al.'s (2019) examination of preservice teachers' perceptions of TPACK pathways by collecting data from 63 female student teachers. Direct significant effects were detected among seven out of a total of nine hypotheses. The results indicated that TK, PK CK, and TPK were positively related to TPACK, except for PCK which was not directly connected with TPACK. The results implied that the preservice teachers' TK could be somehow insufficient compared to their PK and CK.

Modeling investigations have also explored direct effects of TPACK components. For instance, Kiray et al.'s (2018) study indicated that TCK, TPK, and PCK had significant direct and positive influences on TPACK. PCK influenced TPACK to the largest degree. Additionally, science teachers' CK had a direct and positive impact on their TCK and PCK, and this was a more robust influence compared with the effect of TK and PK. Similarly, Celik et al. (2014) investigated the relationships among the knowledge forms of the TPACK model. Based on the data coming from the perceptions of 744 Turkish pre-service teachers, it was found that those who were more knowledgeable in technology had also more PK and CK. Also, PK as the basic form of the TPACK had a significant impact on the rest of constructs including the TPACK itself. In addition to this, PCK and TCK had direct

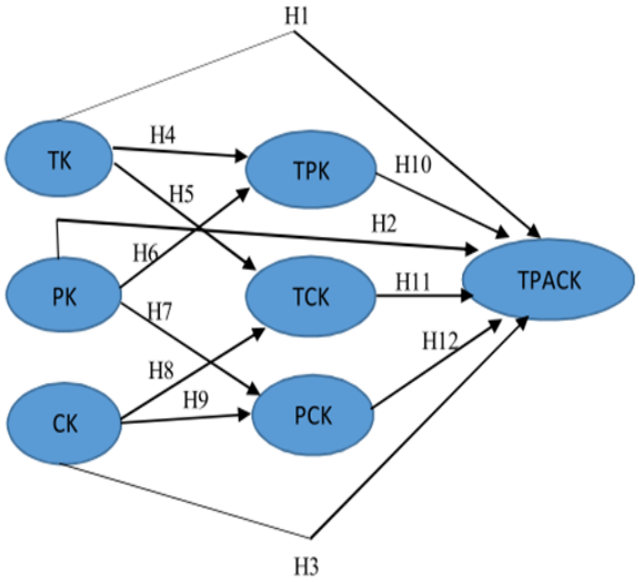
influences over the TPACK. In the same vein, Habibi et al. (2020) probed into Indonesian EFL pre-service teachers' use of ICT (UICT) and its integration into their teaching practices in light of the TPACK. Research findings supported all the hypotheses related to the interrelationships of TPACK competencies.

Overall, these studies provide somewhat inconsistent evidence regarding associations between the constructs of TPACK. It is, therefore, necessary to carry out more investigations into the TPACK framework involving teaching practitioners from other fields of study and educational settings. Moreover, as teachers will be consumers of interactive technologies in the long run, heed must be paid to the way teachers' TPACK develops in harmony with technology, pedagogy, and content and their interrelationships.

A primary structural model was introduced to explore the causal relationships amongst the components of the TPACK following Mishra and Koehler's (2006) seven-factor model (see Figure 2). According to the model, the interplays of the three major variables (TK, PK, CK), functioning as exogenous variables, form the other three combined constructs (TPK, TCK, PCK) as endogenous variables, which eventually lead to TPACK as the end result of the model. To this end, five general hypotheses were formulated from which seven more specific hypotheses were derived to be tested in the experiment in order to examine twelve possible pathways to TPACK through structural equation modeling technique.

Figure 2

Primary Structural Model



1. TK, PK, and CK will have statistically significant (positive and direct) effects on EFL teachers' TPACK.
2. TK will have statistically significant (positive and direct) effects on EFL teachers' TPK and TCK.
3. PK will have statistically significant (positive and direct) effects on EFL teachers' TPK and PCK.
4. CK will have statistically significant (positive and direct) effects on EFL teachers' TCK and PCK.
5. TPK, TCK, and PCK will have statistically significant (positive and direct) effects on EFL teachers' TPACK.

3. Method

3.1. Research Design

The present research deployed a quantitative, non-experimental survey research design. Based on what Creswell (2012) argued, survey research designs are procedures in quantitative research through which researchers gather numerical data by making use of questionnaires or interviews and analyzing them statistically in order to describe the attitudes, behaviors, or characteristics of the surveyed population and to examine research questions and hypotheses.

3.2. Participants

A cohort of teachers as the participants of the study were selected through a non-probability convenience/availability sampling technique (Best & Kahn, 2006) consisting of 160 full-time or part-time EFL teachers currently working in Private Language Schools (PLSs) located in Isfahan. The rationale behind selecting EFL teachers from afore-mentioned schools was to include a vaster array of teachers from various educational backgrounds, teaching experience, and instruction levels.

Prior to going through data collection, the respondents were informed about the purpose of the study, filling instructions, privacy concerns, confidentiality measures, and their voluntariness. To do so, all participants were to read the survey guide and give their consent to voluntary participation by checking the box provided in the survey.

According to the demographic data in Table 1, 69.4 % of the research participants were females (N = 111) and 30.6 % were males (N = 49). 96.3 % of teachers majored in English (N = 154) while 3.7 % studied majors other than English (N = 6). 2.5 % of participants were BA students (N = 4), and 41.9 % held master's degrees. 33.8 % of teachers' age ranged from 31 to 35 (N = 54) while 11.9 % of teachers' age was over 40 (N = 19). 39.4 % of

teachers had 1-5 years of teaching experience (N = 63) while 4.4 % served 16-20 years (N = 7).

Table 1

Demographic Profile of the Participants (N = 160)

Feature	Category	Frequency	Percentage
Gender	Male	49	30.6
	Female	111	69.4
Major	English	154	96.3
	Non-English	6	3.7
Educational Level	BA Student	4	2.5
	BA Graduate	14	8.8
	MA Student	41	25.6
	MA Graduate	67	41.9
	PhD Student	25	15.6
	PhD Graduate	9	5.6
Age Group	20-25	31	19.4
	26-30	30	18.8
	31-35	54	33.8
	36-40	26	16.3
	over 40	19	11.9
Teaching Experience (in years)	1-5	63	39.4
	6-10	52	32.5
	11-15	25	15.6
	16-20	7	4.4
	over 20	13	8.1

3.3. Instrument

The research survey comprised two sections. The first section gathered data on four demographic features including gender, major, age group, and years of teaching experience. The second section gleaned information from respondents by providing them with the TPACK-EFL survey (Baser et al., 2016).

As TPACK-EFL questionnaire was supposed to be used in a new context and with different participants, it was expert-viewed for content validity by three experts. According to their feedback, some minor modifications were made in the content of the survey in the way that all general *technology* and *computer* terms were replaced with Web 2.0 terms to reflect the idea of Web 2.0 technologies. This adaptation led to the generation of a 38-item questionnaire entailed surveying EFL teachers' perceived

knowledge regarding the range of their disagreement to agreement on the statements purported to each TPACK factor. Each statement on the survey was set on a five-point Likert-type scale including *strongly disagree, disagree, neutral, agree, and strongly agree*. The final questionnaire contained eight TK items, five CK items, six PK items, five PCK items, three TCK items, seven TPK items, and four TPACK items. The reliability of the instrument was measured through a pilot study using subjects whose characteristics were similar to the ones who would participate in the main research project.

3.4. Procedure

The current study took the following steps to collect the required data. Initially, the teachers were provided with some information on the purpose of the study and the instructions for completing the soft version of the survey that contained items dealing with their TPACK perceived levels and demographic features (e.g., gender, major, age, and teaching experience). Data were compiled during a four-week period via an online link on Google Forms sent to participants' Telegram accounts or their email addresses, which saved time and cost. To prevent the participants from duplicating responses, the "Limit to One Response" feature on Google Forms was added. Secondly, the EFL teachers filled out the survey copies and returned the responses online.

The scope of the study made the researchers place several limitations on the study, including theoretical framework, sampling procedure, setting, sample size, instrumentation, data collection procedure and methodology, which imposed the delimitations of the study for various practical reasons due to time pressure, insufficient financial resources, limited access to participants, and permit considerations.

3.5. Data Analysis

The numerical data were entered into SPSS v. 22 then Amos v. 24 for the statistical analysis. Before beginning to do any work on data sets of the study, outliers were excluded by checking the data via SPSS to the effect that of one hundred and seventy-three teachers taking part in the study, thirteen respondents were discarded due to inconsistent responses and unreliable data provision. Regarding the research purpose and the utilized scale, various types of statistical analysis were carried out, which included descriptive statistics, one-sample t-test, and Pearson correlation using SPSS as well as confirmatory factor analysis (CFA) and structural equation modeling (SEM) techniques through analysis of moment structures known as Amos statistical package.

First, the current state of research variables was examined using a one-sample t-test to determine the mean score. Second, confirmatory factor analysis (CFA) was run to test the measurement models comprising seven latent constructs of TPACK and to verify the construct validity of the instrument. Third, intercorrelations between constructs were presented based on descriptive statistics values including mean, standard deviation (SD), and Cronbach's alpha coefficients. The hypothesized model in Fig. 2 was then specified in Amos 24.0. Afterward various model fit indices were taken into account and path coefficients of the hypothesized relationships were examined intending to test the research hypotheses. Satisfactory fit indices of primary research model would be indicated if the analysis yielded the following values including Chi-Square/df ratio ($\chi 2$/df) < 5 depending on the sample size (Hooper et al., 2008), root-mean square error of approximation (RMSEA) equal to or < 0.05 (Byrne, 2010), comparative fit index (CFI) > 0.95, root-mean squared residual (SRMR) equal to or < 0.05 (Schumacker & Lomax, 2016) and Tucker-Lewis index (TLI) > 0.90 (Arbuckle, 2017).

4. Results and Discussion

4.1. Results

4.1.1. Descriptive Statistics

As presented in Table 2, the current state of research variables shows that all research variables are placed above the hypothesized mean value (M = 3) significantly ($p < 0.05$). CK had the greatest mean score (M = 4.35) and TK had the lowest one (M = 3.80) amongst the seven constructs of TPACK.

Table 2

Results of One-Sample T-Test for Research Variables

	Test Value = 3					
Variables	t	df	Mean	Sig. (2-tailed)	95% Confidence Interval of the Difference	
					Lower	Upper
TK	14.89	159	3.80	.001	.701	.915
CK	31.85	159	4.35	.001	1.273	1.441
PK	28.03	159	4.16	.001	1.084	1.248
PCK	29.39	159	4.28	.001	1.194	1.366
TCK	15.16	159	3.86	.001	.752	.977
TPK	17.85	159	3.83	.001	.740	.925
TPACK	16.20	159	3.85	.001	.747	.955

4.1.2. Confirmatory Factor Analysis

Based on seven latent constructs of the TPACK framework (TK, CK, PK, PCK, TCK, TPK, TPACK) and the 38-item survey that measured each related variable, a measurement model was determined in Amos v. 24.0. First-order confirmatory factor analysis (CFA) was deployed to measure the construct validity of the research instrument items (Schumacker & Lomax, 2016). Accordingly, measurement models were examined based on the items of each construct then good fit indices were provided.

Table 3

CFA Fit Indices of the Measurement Models

No	Fit Index Model	χ2	df	χ2/df	TLI	CFI	RMR	RMSEA
1	TK	32.90	18	1.82	0.96	0.97	0.030	0.072
2	CK	0.80	3	0.26	1.00	1.00	0.004	0.001
3	PK	13.09	8	1.63	0.97	0.98	0.017	0.063
4	PCK	9.75	5	1.95	0.97	0.98	0.011	0.077
5	TCK	--	--	--	--	--	--	--
6	TPK	23.71	13	1.82	0.96	0.97	0.023	0.072
7	TPACK	1.40	1	1.40	0.99	0.99	0.006	0.050
Good Fit		--	--	< 5	> 0.9	> 0.9	< 0.05	< 0.08

Note. RMSEA= root-mean square error of approximation; CFI= comparative fit index; TLI= Tucker-Lewis index; RMR = root mean squared residual

Table 3 reflects good fit indices of the measurement models through running first-order CFA (see *χ2/df*, TLI, CFI, RMR, & RMSEA values). Thus, factor models are confirmed and the selected items for measuring the latent constructs enjoy required validity. Since TCK contains three items, the confirmatory factor model is saturated, with the result that model fit indices are not provided. According to Kline (2011), if the factor loading value of an item for a construct is greater than .50 then the item can reflect the latent construct optimally. Factor loadings of almost all the items for research constructs demonstrated that the selected items enjoyed values greater than .50 and as the critical ratios (CR) of the items are greater than 1.96, they are statistically significant at .05 level. Therefore, it can be asserted that the selected items correctly explain the latent constructs resulting in confirming the construct validity of the models.

4.1.3. Correlation Analysis

Having confirmed the measurement models, Pearson correlation was run to establish the existence of intercorrelations between TPACK constructs. Table 4 presents mean values, SDs, Cronbach's alpha coefficients, and correlations between the variables of research. Zero-order correlations

between TPACK variables indicate that there is the highest correlation between TPK and TPACK (r = 0.77, p < 0.01) and the lowest correlation exists between PCK and TPACK (r = 0.27, p < 0.01). According to the results of correlation coefficients of constructs, the reliability of the instrument was ensured.

Table 4

Constructs Inter-Correlations and Descriptive Statistics Matrix [a]

	Variables	Mean	SD	1	2	3	4	5	6	7
1	TK	3.80	0.68	**(0.89)**						
2	CK	4.35	0.53	0.40**	**(0.85)**					
3	PK	4.16	0.52	0.40**	0.56**	**(0.84)**				
4	PCK	4.28	0.55	0.29**	0.61**	0.71**	**(0.88)**			
5	TCK	3.86	0.72	0.69**	0.36**	0.45**	0.35**	**(0.84)**		
6	TPK	3.83	0.59	0.66**	0.40**	0.49**	0.44**	0.69**	**(0.88)**	
7	TPACK	3.85	0.66	0.67**	0.33**	0.39**	0.27**	0.73**	0.77**	**(0.85)**

Note. [a] *Cronbach's alphas are displayed in parentheses along the diagonal.*
N = 160 ** *P < 0.01*

4.1.4. Structural Path Analyses

As shown in Table 5, hypothesis testing results of the path coefficients of the structural model indicated that eight of the 12 hypotheses were supported. It can be observed that the direct and positive impacts of Web 2.0 technological knowledge, pedagogical knowledge, and content knowledge on EFL teachers' TPACK were insignificant. Likewise, CK did not influence TCK significantly. Moreover, examining the direct and positive effects of other variables exhibited that TK affected EFL teachers' TPK and TCK. PK influenced EFL teachers' TPK and PCK and CK influenced EFL teachers' PCK. Findings also showed that TPK, TCK, and PCK had direct and positive influences on EFL teachers' TPACK.

Nevertheless, there were no direct paths of TK, PK, and CK to TPACK as it is presented with dashed lines indicating non-significant relationships. In addition to these contrasting findings, it was demonstrated that TK had a direct and positive effect on EFL teachers' TPK and TCK, which were more robust than the effect of PK on TPK and PCK. The direct influence of CK on PCK was also established while CK was not related to TCK significantly, which is shown with broken lines (see Figure 3).

As depicted in Fig. 3, path coefficients of the interrelationships of the original model with 20000 bootstrap replications are provided. The trimmed model is presented after removing the insignificant direct effects of the path coefficients. From the results, it is clear EFL teachers went through three trajectories of TPK, TCK, and PCK towards TPACK.

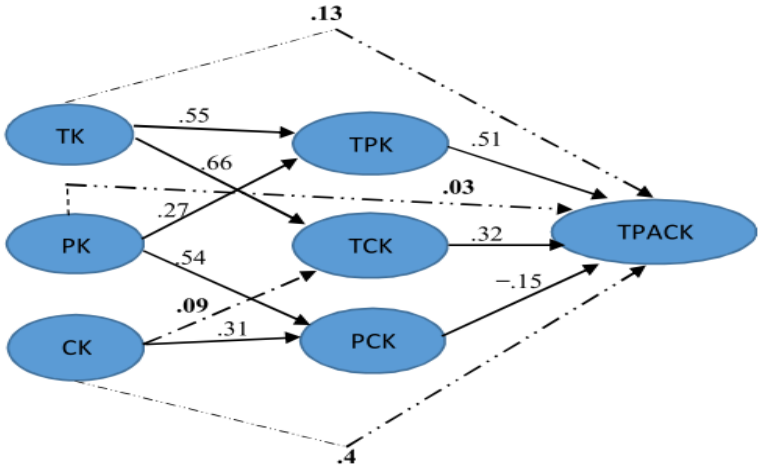
Table 5

Results of Path Coefficients of the Hypothesized Relationships

Hypothesis	Path	Path coefficient	Bootstrap confidence interval		P	Result
			Lower	Upper		
H1	TK⟶TPACK	0.13	- 0.027	0.295	0.108	Unsupported
H2	PK⟶TPACK	0.03	- 0.101	0.176	0.639	Unsupported
H3	CK⟶TPACK	0.04	- 0.068	0.145	0.455	Unsupported
H4	TK⟶TPK	0.55	0.42	0.65	0.001	Supported
H5	TK⟶TCK	0.66	0.53	0.76	0.001	Supported
H6	PK⟶TPK	0.27	0.16	0.38	0.001	Supported
H7	PK⟶PCK	0.54	0.40	0.66	0.001	Supported
H8	CK⟶TCK	0.09	- 0.03	0.21	0.153	Unsupported
H9	CK⟶PCK	0.31	0.15	0.46	0.001	Supported
H10	TPK⟶TPACK	0.51	0.33	0.65	0.001	Supported
H11	TCK⟶TPACK	0.32	0.13	0.49	0.001	Supported
H12	PCK⟶TPACK	- 0.15	- 0.27	- 0.02	0.024	Supported

Figure 3

Path Coefficients of the Hypothesized Relationships of the Research Model



As demonstrated in Table 6, a satisfactory goodness of fit level ($\chi 2$ = 6.37; $\chi 2/df$ = 1.59; TLI = 0.98; CFI = 0.99; RMR = 0.006; RMSEA = 0.061) was achieved. Therefore, it can be stated that the proposed model portrayed good fit to the sample data.

Table 6

Fit Indices of the Primary Research Model

Fit Index Model	$\chi 2$	df	$\chi 2$/df	TLI	CFI	RMR	RMSEA
TPACK	6.37	4	1.59	0.98	0.99	0.006	0.061
Good Fit	--	--	< 5	> 0.9	> 0.9	< 0.05	< 0.08

4.2. Discussion

The current study revolved around testing a structural model to examine possible trajectories perceived by EFL teachers towards TPACK of Web 2.0 technologies. It was indicated that no direct and positive relationship was found between TK, PK, CK, and TPACK, but direct and positive causal relationships were perceived between TCK, TPK, PCK, and TPACK. Besides, TK influenced both TPK and TCK directly; PK affected both TPK and PCK directly; CK was related to PCK significantly but it did not influence TCK. All in all, of 12 hypotheses, eight were supported by the data. Most of the findings of the study are in agreement with the studies done to investigate the causal relationships among factors of the TPACK model even though some contrary results are also observed. Among all sub-domains of TPACK, it can be seen that the effects of TK on TPK and TCK and PK on PCK are the strongest whereas the positive influences of TK, PK, and CK on TPACK and CK on TCK are the weakest among all the other effects.

According to the findings of the study, core knowledge domains including TK, CK, and PK did not influence TPACK directly, which is completely in line with Chai et al. (2013), Pamuk et al. (2013), Schmid et al. (2020), and Yang et al. (2019). The insignificant relationship between TK and TPACK might originate from the fact that being competent in one knowledge domain does not necessarily lead to its implementation. That is to say, although EFL teachers possessed acceptable knowledge of Web 2.0 devices, they could not gear up for proper implementation due to a lack of self-efficacy and interest on the personal level or a lack of suitable professional development or training programs on the organizational level. In their study, Liu and Kleinsasser (2015) discussed that teachers of English as a foreign language needed to develop and strengthen their PK and CK to go along with TPK, TCK, and TPACK equally. Some contrary findings were found regarding the associations of TK, PK, and CK in Habibi et al. (2020) and Khine et al. (2019) where all three competencies were related to the core component, which is believed to explicate 72% of the variance in TPACK. Additionally, Sen (2020) discussed that the increase in TPACK would be dependent on TK and CK.

The dissociation between CK and TPACK could come from the way content was treated in the survey items related to CK and TPACK. The

content was considered as only general language skills and no attention was paid to the intricacies involved in English language as a subject matter in terms of other competencies. This is in line with the study performed by Koh et al. (2013). Finally, the lack of significant statistical association between PK and TPACK may come about EFL teachers' perceptions regarding a relative lack of pedagogical elements in the TPACK domain to implement Web 2.0 technologies in teaching. All in all, it can be stated that the lack of relationships could be methodological and contextual in nature. Although these types of knowledge comprise the core parts of TPACK, they do not individually affect the core construct due in part to the fact that these bodies of knowledge could indirectly influence TPACK.

TK and PK influenced EFL teachers' TPK directly and positively. This explains the point that knowledge of Web 2.0 technologies and pedagogy of EFL teachers might contribute to developing new pedagogical practices with Web 2.0 technologies in mind. Similar results were obtained by Chai et al. (2013), Pamuk et al. (2013), Habibi et al. (2020), Khine et al. (2017), Yang et al. (2019), Khine et al. (2019), and Schmid et al. (2020). Although EFL teachers have a clear understanding of Web 2.0 technologies in L2 pedagogy, they might not be certain to use such devices.

TK and CK influenced EFL teachers' TCK differently. TK had a positive and direct effect on TCK, which was the strongest impact among all other constructs. This is congruent with the findings of Chai et al. (2013), Habibi et al. (2020), Yang et al. (2019), and Pamuk et al. (2013). This finding shows that TK and CK develop teacher knowledge base differentially as the effects of the two knowledge types vary considerably according to the results. The effect of TK on TCK is much higher when compared to CK. This could explain that possessing knowledge of Web 2.0 technologies can enhance knowledge of technologically-related content. It also indicates that Web 2.0 technological knowledge is directly geared to teaching English via 21st century skills. Meanwhile, CK did not influence TCK. This can be construed as the fact that EFL teachers' knowledge of subject matter is not as effectual and adequate as their knowledge of Web 2.0 technologies when these sub-domains merge. Some opposite findings were presented in Chai et al. (2013), Pamuk et al. (2013), Yang et al. (2019), and Schmid (2020) where CK was related to TCK directly and positively.

PK and CK influenced EFL teachers' PCK directly and positively. This is consistent with what has been found in prior research by Habibi et al. (2020), Yang et al. (2019), Schmid et al. (2020), and Pamuk et al. (2013) but in some other studies, the effect of CK on PCK was statistically insignificant including Chai et al. (2013) and Khine et al. (2017), and Khine et al. (2019). As it can be observed, the effect of PK on PCK is stronger than the effect of PK on TPK. This difference could be noticed, for EFL teachers in Iran are

more inclined to perceive common and mainstream forms of teacher knowledge, which is emphasized by Shulman's (1987) formulation of PCK. Based on the findings, it can be asserted that there is a mutual relationship between teaching techniques and strategies and English as the subject matter and their integration is deemed essential for the teaching profession (Shulman, 1986). As discussed by Hao and Lee (2017), teachers had higher levels of non-technological knowledge possibly because of having more training and experience in PK, CK, and PCK in comparison with technological knowledge bases.

TPK, TCK, and PCK of EFL teachers had direct and positive effects on their TPACK. A similar pattern of results was obtained in Chai et al. (2013), Habibi et al. (2020), and Pamuk et al. (2013). In Khine et al.'s (2019) and Yang et al.'s (2019) studies, it was found that PCK was not associated with TPACK, which was assumed to be due to teachers' lack of specialist knowledge of the content area to influence their students, but TPK was related to TPACK significantly. Kiray et al. (2018) concluded that teachers' ability to integrate the knowledge of pedagogy with content and technology can affect TPACK self-efficacy. Undoubtedly, the integration of technological and pedagogical knowledge forms can enhance teachers' performance in achieving an adequate level of TPACK. As Deng et al. (2017) put it, teachers ought to be taught how to integrate TPK, TCK, PCK as epistemological knowledge domains to reach an adequate level of TPACK. Additionally, PCK is believed to be the most important knowledge base among all the other ones. This is so because if a technologically-knowledgeable teacher cannot deliver English content such as grammar and pronunciation well, s/he will not be able to teach English through technology properly. On the contrary, Deng et al. (2017) in a study on pre-service chemistry teachers argued that in spite of gaining certain PCK during the teacher education program, the teachers still fell short of having enough experience in effectively integrating technology, pedagogy and their specialist content area in the courses assigned by the university. In Zhang et al.'s (2019) study, it was indicated that PCK and TPACK correlated in primary school teachers' online discourse. A similar finding was reported in Sen's (2020) study of chemistry teachers.

5. Conclusion and Implications

To sum up, this research has investigated Iranian EFL teachers' knowledge of Web 2.0 technology, pedagogy, and content by examining the interconnections of a TPACK-based structural model. The results of this study indicated that TK, CK, and PK did not influence TPACK directly and positively, whereas the second level knowledge sources including TCK, TPK, and PCK influenced TPACK positively and directly. In addition, TK, CK, and PK affected TCK, TPK, and PCK, but CK had no effect on TCK. The findings of this

investigation add substantially to our understanding of EFL teachers' CALL competency in a new educational context. The findings expand the ongoing research on TPACK theoretically by integrating Web 2.0 technologies into the framework. It also contributes to current literature due to insufficient research done in EFL contexts to analyze possible causal relationships through a SEM approach.

The scope of this study was limited in terms of the sample size, lack of access to other EFL teaching practitioners from public educational contexts, sampling procedure, and the use of quantitative measures. A key strength of this study was the use of structural modeling technique to analyze the interrelationships between the TPACK constructs.

Further research is imperative to validate the kinds of conclusions that can be drawn from this study. Of special interest would be the research that could be carried out on pre-service and in-service teachers of English in Iran and other parts of the world where English is taught as a foreign or second language. Teacher education and teacher professional development programs on Web 2.0 can be devised in which the effect of TPACK is investigated in pre-post experiments. Case studies can be carried out in which the role of TPACK and teachers' self-efficacy to use different instances of Web 2.0 devices will be examined. Last but not least, confirmatory research is one of the other options to replicate this study in different contexts, across various subject areas and levels of education to explore teachers' perceptions even further.

Recently, with the permeation of digital technologies in the Iranian EFL context, teachers have begun to take an interest in using the affordances of Web 2.0 technologies in their classes more and more. Owing to the importance of technology integration into foreign language education, some language scholars examined Iranian EFL teachers' TPACK areas. (Bagheri, 2020; Nazari et al., 2019; Rahimi & Pourshahbaz, 2016). However, previous work has only focused on describing the teachers' competence and no attempt has been made to examine the pathways of TPACK of Web 2.0 technologies via structural equation modeling.

The current research can have both pedagogical and theoretical implications in the field of English language teaching. Pedagogically speaking, the research has direct implications for EFL teacher educators, school administrators, and other stakeholders to be encouraged to develop TPACK-based professional programs on Web 2.0 for EFL teachers. Teacher education and professional development programs are to aim at integrating English content knowledge and technological knowledge into the educational process. Moreover, EFL educationalists in Iran may look for ways to back the development of learner pedagogical abilities with Web 2.0 devices and encourage the integration of technology into English language teaching.

In order to gain success in raising the level of Web 2.0 use in EFL situations, teacher education and professional development programs should concentrate on knowing how to use technology for language learning. Courses seeking to improve TPACK of Web 2.0 would have to be designed and tested within the EFL teacher training curricula to establish their quality and strength. Within these courses, teacher educators would set clear learning goals that ought to be achieved through proper Web 2.0 technologies, and create favorable learning environments for both pre-service and in-service EFL teachers to develop their TPACK. During this process, EFL teachers would need opportunities to examine innovative computer-assisted language learning practices on their own and be offered more technology-oriented workshops to demonstrate their ability in acquiring specialized knowledge.

Moreover, TPACK has often been censured for its weak theory-practice nexus (Koh et al., 2013; Njiku et al., 2020; Willermark, 2018). This research can be one of the attempts that could fill the gap by providing data to illustrate the interrelationships among different constructs of the model to test the TPACK model empirically.

From a theoretical standpoint, there has been much debate on the theoryless nature of the role of technology in education (Koehler et al., 2012). With the introduction and expansion of TPACK as a sound theoretical framework to investigate the impact of technology in teaching, it has aroused much interest in various educational fields. In so doing, different measures and scales were validated and developed to understand the teachers' expertise in using technology. This research was one of the rare studies in which a validated survey was used to examine EFL teachers' perceptions. Using the data coming from a TPACK-EFL survey, this experiment can contribute to the extant EFL surveys by focusing on a particular aspect of educational technology (Web 2.0), which might eventually give rise to empowering the theoretical basis of TPACK.

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Appendix

Section I: Demographic Data

Gender:

□ Male

□ Female

Major:

□ English

□ Non-English

Educational Level

□ Bachelor Student

□ Bachelor Graduate

□ Master's Student

□ Master's Graduate

□ PhD Student

□ PhD Graduate

Age Group:

□ 20-25

□ 26-30

□ 31-35

□ 36-40

□ Over 40

Teaching Experience (in years):

□ 1-5

□ 6-10

□ 11-15

□ 16-20

□ Over 20

Section II: TPACK-EFL Questionnaire (adapted from Baser, D., Kopcha, T. J., & Ozden, M. Y., 2016).

Thinking of Web 2.0 technologies (e.g., Instagram, Telegram, YouTube, Facebook, etc.), to what extent do you agree or disagree with the following statements? Please specify the option that describes you best.

○ Strongly Disagree ○ Disagree ○ Neutral ○ Agree ○ Strongly Agree

Technological Knowledge (TK)

1. I can use basic Web 2.0 technological terms (e.g., applications, Wi-Fi, websites, etc.) appropriately.
2. I can adjust Web 2.0 software and application settings.
3. I can troubleshoot common Web 2.0 technological problems (e.g. video chat connection problems, etc.) independently.
4. I can use Web 2.0 classroom equipment such as projectors and smart boards.
5. I can use Web 2.0 document suites (i.e. Google Drive, Google Docs, etc.) with a high level of proficiency.
6. I can create Web 2.0 multimedia (e.g. video, web pages, etc.) using text, pictures, sound, video, and animation.
7. I can use Web 2.0 collaboration tools (Wiki, Skype, 3D virtual environments, etc.) in accordance with my objectives.
8. I can learn Web 2.0 software and devices that help me complete a variety of tasks more efficiently.

Content Knowledge (CK)

9. I can express my ideas and feelings by speaking in English.
10. I can express my ideas and feelings by writing in English.
11. I can read texts written in English with the correct pronunciation.
12. I can understand texts written in English.
13. I can understand the speech of a native English speaker easily.

Pedagogical Knowledge (PK)

14. I can use teaching methods and techniques that are appropriate for a learning environment.

15. I can design a learning experience that is appropriate for the level of students.

16. I can support students' learning in accordance with their physical, mental, emotional, social, and cultural differences.

17. I can collaborate with school stakeholders (students, parents, teachers, etc.) to support students' learning.

18. I can reflect the experiences that I gain from professional development programs to my teaching process.

19. I can support students' out-of-class work to facilitate their self-regulated learning.

Pedagogical Content Knowledge (PCK)

20. I can manage a classroom learning environment.

21. I can evaluate students' learning processes.

22. I can use appropriate teaching methods and techniques to support students in developing their language skills.

23. I can prepare curricular activities that develop students' language skills.

24. I can adapt a lesson plan in accordance with students' language skill levels.

Technological Content Knowledge (TCK)

25. I can take advantage of Web 2.0 multimedia resources (e.g. video, slideshow, etc.) to express my ideas about various topics in English.

26. I can benefit from using Web 2.0 technology (e.g. web conferencing and discussion forums) to contribute at a distance to multilingual communities.

27. I can use Web 2.0 collaboration devices to work collaboratively with foreign persons (e.g. Second Life, Wiki, etc.).

Technological Pedagogical Knowledge (TPK)

28. I can meet students' individualized needs by using Web 2.0 technologies.

29. I can lead students to use Web 2.0 technologies legally, ethically, and safely.

30. I can support students as they use Web 2.0 technology such as virtual discussion platforms to develop their higher order thinking abilities.

31. I can manage the classroom learning environment while using Web 2.0 technologies in the class.

32. I can decide when Web 2.0 technologies would benefit my teaching of specific English curricular standards.

33. I can design learning materials by using Web 2.0 technologies that support students' language learning.

34. I can use Web 2.0 multimedia resources such as videos and websites to support students' language learning.

Technological Pedagogical Content Knowledge (TPACK)

35. I can use Web 2.0 collaboration devices (e.g. Wiki, Skype, 3D virtual environments, etc.) to support students' language learning.

36. I can support students as they use Web 2.0 technologies to support their development of language skills in an independent manner.

37. I can use Web 2.0 devices (Instagram, podcasts, etc.) to develop students' language skills.

38. I can support my professional development by using Web 2.0 devices and resources to continuously improve the language teaching process.