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REGULAR ARTICLE

The Relationship Between Teachers' Online Homework Guidance and Technological Pedagogical Content Knowledge about Educational Use of Web

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Abstract The development of e-learning and digital campus has prompted more and more teachers to assign online homework to students. Consequently, teachers need to provide sufficient and relevant guidance for such homework. Teachers' online homework guidance (TOHG) is conceptually connected with their level of technological pedagogical content knowledge about educational use of Web (TPACK-W). This study employed two questionnaires: a self-developed questionnaire for TOHG and a revised TPACK-W questionnaire to study how TOHG is associated with TPACK-W through correlation and regression analysis. Two hundred and eighty-four teacher participants from China who had experience in assigning online homework were asked to complete the questionnaires. This study validated the questionnaires and established significant relationship between the TOHG and TPACK-W. The study expanded current understanding of TPACK through the factors associated with online homework. The findings showed that the level of teachers' online homework guidance was significantly related to their TPACK-W, and the two factors of Web-Pedagogical Knowledge and Web-Pedagogical-Content Knowledge in the TPACK-W questionnaire could predict the TOHG. Future teachers' professional development for the construction of TPACK-W should include discussions and guidelines of online homework.

Keywords Online homework · TPACK-W · Online teaching · E-learning · Online tutor

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Introduction

The development of e-learning and digital campus offers more teaching and learning opportunities for teachers and students (Cela et al. 2015). Many teachers are likely to assign online homework and provide some guidance to students in doing the homework. Students' engagement in the online homework (Perdian 2013), also known as web-based homework (Roth et al. 2008) or Internet-based homework (Bowie et al. 2013), improved students' academic performance (Richards-Babb and Jackson 2011). Studies have also indicated that students who completed the online homework performed significantly better than those who did traditional homework (Demirci 2010; Malik et al. 2014).

This paper defines online homework as any form of homework that needs to be completed via the Internet. For example, teachers may invite students to search for more information related to what they learn in class, or to design a poster by exploring online. These are open-ended questions that encourage students to build deeper understanding. Online homework can also be close-ended questions assigned via online homework system and students can receive immediate feedbacks (Eichler and Peeples 2013).

For students' smooth completion of homework, it is necessary for teachers to provide instructions and support (Hagger et al. 2016; Radovanovic and Slisko 2014). However, how teachers provide guidance for online homework has not yet received much attention. Conceptually, the guidance provided to the students is related to the teachers' pedagogical knowledge. And how teachers are able to assign homework and assure students of finishing homework on the Internet are premised upon both the teachers and their students' grasp of technological knowledge. Pedagogical knowledge, together with technological knowledge, is obviously related to the teachers' level of technological pedagogical content knowledge about educational use of Web (i.e., TPACK-W) (Lee and Tsai 2010). However, recent reviews of technological pedagogical content knowledge (TPACK) (Chai et al. 2013, 2016; Voogt et al. 2013) do not include online homework as part of TPACK research. In addition, the questionnaire specifically designed for Web-based TPACK (Archambault and Barnett 2010; Archambault and Crippen 2009; Kavanoz et al. 2015; Lee and Tsai 2010) needs to be improved. In this era of e-learning, students' ability to engage productively with online homework would be part of the repertoire for being life-long learners and teachers need to pay attention to this aspect of TPACK-W. Therefore, this study aims to develop and validate a questionnaire to survey and to assess the level of teachers' online homework guidance (TOHG). And the TPACK-W questionnaire (Lee and Tsai 2010) was revised and improved to explore the relationship between TOHG and TPACK-W.

Literature Review

The Research on Online Homework and its Guidance

The popularity of digital technologies and e-learning offer both opportunities and challenges for education (Law et al. 2010). Teachers are increasingly enhancing their teaching using network technology. And more students are apt to learn online (Kozlov and Grosse 2016). It has been noted that online homework begins to supplement traditional homework (Bonham et al. 2003) and types of online homework are likely to be more varied.

The issues on traditional homework or online homework have received some attention among researchers and practitioners. Studies about traditional homework showed the concern over motivation and emotional support from parents (Gonida and Cortina 2014). It has also been identified that time spent (Javier Murillo and Martinez-Garrido 2013), time management (Xu et al. 2014), and parental support (Katz et al. 2011) helped improve the quality of traditional homework. As for online homework system, they could provide students with accessible supplementary learning resources which usually help students to better understand the subject matter (Richards-Babb and Jackson 2011).

Assigning online homework can help students acquire Internet literacy which includes Internet skill and information literacy (Kim and Yang 2016). Students can be vulnerable when exposed to a bewildering array of Internet information (Wegmann et al. 2015). They could get overwhelmed or distracted when doing their homework online. They are more likely to use Internet for leisure, and doing online homework could be used as covers for students who are addicted to social networking sites and online games (Leung and Lee 2012). Hence, their online homework is poor in quality. While net addicts are unlikely to have inadequate Internet skill (Leung and Lee 2012), students who do not have much exposure to the Internet may suffer from being unskillful in using the Internet for learning.

The paper defines Internet Literacy broadly as appropriate and legitimate use of the Internet. Internet literacy could be promoted in three aspects: to be aware of the possible harms, to exercise self-control, and to source for useful information for productive learning. Correspondingly, teachers guide students to take precautions against malpractices in using the Internet, to manage time and make the online learning plan, and to have a command of Internet skill and information literacy (Kim and Yang 2016) which refers to how teachers lead students to acquire information, manage information, and appropriately use network tools.

Currently, most researchers focused on the guidance on traditional homework (Xu et al. 2014) or interaction between students and online homework systems (Babaali and Gonzalez 2015; Perdian 2013). This study expanded current understanding through the investigation of how teachers guided students to do their online homework.

The Research on TPACK-W

Since 2005, the TPACK framework has emerged as a crucial framework to understand teachers' integration of ICT in education (Koh et al. 2015; Koehler et al. 2014;

Mishra and Koehler 2006). The TPACK framework has been employed mainly to unpack the complex forms of knowledge that teachers need to design good ICT lessons. Recent development of TPACK research in the area of measuring teachers' TPACK has pointed to the need for the development of specific technology instruments (Chai et al. 2016; Koehler et al. 2014).

With reference to Internet-based technology, a couple of attempts to develop questionnaire have been reported. First, through expert reviews and two rounds of think-aloud piloting, Archambault and associates developed a 24-item instrument to assess the TPACK of online teachers from virtual schools in America (Archambault and Crippen 2009). Factor analysis with varimax rotation extracted only three factors rather than the seven TPACK factors (Archambault and Barnett 2010). These were technology knowledge (TK), a combined factor of pedagogy knowledge (PK), content knowledge (CK), and pedagogical content knowledge (PCK), which was technology-independent, and another combined factor of technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPCK), which was technology-related (Archambault and Barnett 2010). Consequently, the researchers inferred that online teachers could not purposefully separate out the seven factors of TPACK framework.

Lee and Tsai (2010) developed an instrument for assessing teachers' level of technological pedagogical content knowledge about educational use of Web (TPACK-W) and proposed six factors including the Web-general, Web-Communicative, Web-Pedagogical Knowledge (WPK), Web-Content Knowledge (WCK), Web-Pedagogical-Content Knowledge (WPCK), and attitude toward Web-based instruction. The researchers constructed 30 items which eventually yielded five factors after exploratory factor analysis. WPK and WPCK were fused into one factor. The factor structure was further verified by confirmatory factor analysis. The authors suggested that the merging of eight items of WPK and WPCK could be due to insufficient initial number of items for each construct. Kavanoz et al. (2015) adopted the Lee and Tsai's questionnaire to survey preservice teachers' TPACK-W but they did not improve the TPACK-W instrument. These studies illustrated the inherent challenge in measuring web-based or online TPACK and given the importance of e-learning in today's education, further research in this area could facilitate future teacher professional development activities by providing a fully validated instrument (see Chai et al. 2016).

Research Questions

The TPACK-W was adapted and redesigned from previous studies, which aimed to survey the teachers' competencies of using the web for pedagogical purpose. The TOHG was designed in this study to measure one specific aspect of the pedagogical use of the web. Theoretically, the online homework, which is constituted in the form of web-based instruction teachers formulated, is a form of web-pedagogical knowledge. It may constitute an independent subfactor of the teachers WPK. Chai et al.'s study (2012) on preservice teachers' effort in considering cyber well-being issues indicates that cyber well-being can be a separate factor predicting teachers' TPACK. More importantly, their research indicates that TPK could be further factorized to unpack its complex and contextual nature. This study adopted their stance in viewing TOHG as a subfactor of WPK. In addition, given that homework is a follow-up action of the online lesson designed for the students, which is a manifestation of the teachers' TPACK-W, the TOHG should be predicted by the TPACK-W. Base on such analysis, we proposed that the TOHG should be predicted by the teachers' TPACK-W.

Accordingly, the following questions were discussed in this study:

(1) Are the teachers' online homework guidance (TOHG) and technological pedagogical content knowledge about educational use of Web (TPACK-W) valid and reliable?
(2) What are the correlations between TOHG and TPACK-W and what are the TPACK-W factors that predict TOHG?

Method

Participates

By convenience sampling, this study invited teachers in China who had experience in assigning online homework to complete the online questionnaires. 284 teachers (95 males and 189 females) from Beijing, Shanghai, and other cities of China responded to the questionnaire available on a professional online survey tool.

Demographic data collected indicated that the teachers' age ranged between 22 and 58 and the average age was 36.49 (SD = 7.30). The length of their school teaching varied from 1 year to 35 years and the average years of teaching was 14.09 (SD = 8.47) years. Among them, 239 (84.15%) obtained a teaching degree and the other 45 (15.85%) had a postgraduate degree. 90 teachers (31.69%) were teaching grade one to six. 89 (31.34%) of them were 7th-to-9th grade teachers, and the number of teachers who taught grade 10–12 were 105, making up 36.97% of all. Half of the teachers spent about 11–30 h online weekly, and those who spent less than 10 h online accounted for

Table 1 Subscales and literature

Seven subscales	Literature
1. Homework requirement (HR)	Self-developed subscale
2. Learning resources (LR)	Parker and Loudon (2013)
3. Learning content (LC)	Parker and Loudon (2013)
4. Learning method (LM)	Javier Murillo and Martinez-Garrido (2013), Xu et al. (2014)
5. Emotional support (ES)	Gonida and Cortina (2014)
6. Internet technology (IT)	Kim and Yang (2016)
7. Internet protection (IP)	Leung and Lee (2012)

20.4%, while 26.7% of teachers spent more than 30 h weekly. The mean frequency of assigning online homework within a month was 2.73 (SD = 4.07).

Instrument

Drawing from various literature studies (see Table 1), a 28-item (see Table 2) instrument was designed to assess the level of teachers' online homework guidance (TOHG). TOHG involved seven subscales and was described below:

(1) *Homework requirement (HR)* In general, HR refers to basic guidance for any online homework, such as the deadline, the way to submit, and the document format. It has not been previously studied probably because it was considered as a matter of routine. However, for comprehensive understanding of the teachers' practice, it was included and the researchers constructed the items themselves based on the Internet context.

Table 2 Rotated factor loadings, mean and standard deviation values, and Cronbach's alpha values for the five subscales of TOHG

Factors	Item loading
Factor 1: Homework Requirement (HR), $\alpha = 0.95$, Mean = 3.87, SD = 0.91	
HR1. I would elaborate content requirements for online homework	0.77
HR2. I would delineate how to finish online homework. (e.g., aided by parents)	0.80
HR3. I would inform definitely my students of the start time and the deadline for the homework	0.78
HR4. I would specify the document format of the online homework. (e.g., by.doc or.ppt)	0.72
Factor 2: Learning Resource (LR), $\alpha = 0.94$, Mean = 3.74, SD = 0.91	
LR1. I would provide Internet resource related to online homework for my students	0.64
LR2. I would recommend Internet communication platforms, such as Micro blog, to students to discuss the problems they encounter when they do their online homework	0.71
LR3. I would answer students' problems they encounter when they do their online homework	0.61
LR4. I would provide my students' cases of online homework for reference	0.61
Factor 3: Learning Content and Method (LCM), $\alpha = 0.97$, Mean = 3.69, SD = 0.92	
LCM1. I would point out the inaccurate content presented by students in their online homework	0.63
LCM2. I would provide individual help to students who need guidance about the content of online homework	0.69
LCM3. I would summarize the common problems of students related to online homework	0.66
LCM4. I would request students to make a suitable plan for his or her online learning	0.73
LCM5. I would give students some practical advice on online learning plan	0.79
LCM6. I would arrange for students to exchange their experiences of doing their online homework	0.75
LCM7. I would urge the students to summarize and review their online homework regularly	0.77
LCM8. I would remind parents to supervise their children's online homework	0.72
Factor 4: Internet Technology (IT), $\alpha = 0.91$, Mean = 3.80, SD = 0.90	
IT1. I would teach students how to screen useful information from large amount of information	0.60
IT2. I would teach students how to conduct information management	0.64
IT3. I would recommend some practical Internet tools to students. (e.g., Evernote, time management software)	0.75
Factor 5: Internet Protection (IP), $\alpha = 0.94$, Mean = 4.10, SD = 0.86	
IP1. I would remind students to protect their privacy when they surf the Internet	0.67
IP2. I would remind students not to click on any irrelevant hyperlinks at random	0.80
IP3. I would guide students to use Internet in an ethical manner	0.88
IP4. I would guide students to avoid Internet addiction	0.87

Overall alpha: 0.98

Total variance explained: 85.41%

Table 3 Rotated factor loadings, mean and standard deviation values, and Cronbach's alpha values for the four subscales of the TPACK-W

Factors	Item loading
Factor 1: Web Knowledge (WK), $\alpha = 0.88$, Mean = 4.47, SD = 0.69	
WK1. I am able to print out the content of a Website	0.71
WK2. I am able to download pictures from the Web	0.69
WK3. I am able to use the Web search engines	0.66
Factor 2: Web-Content Knowledge (WCK), $\alpha = 0.96$, Mean = 4.44, SD = 0.70	
WCK1. I know how to search online resources for course content	0.86
WCK2. I know how to select proper content from Web resources	0.85
WCK3. I am able to search related online materials for course content	0.89
WCK4. I am able to search for various materials on the Web to be integrated into course content	0.88
Factor 3: Web-Pedagogical Knowledge (WPK), $\alpha = 0.86$, Mean = 4.07, SD = 0.84	
WPK1. I am able to teach with Internet in class	0.80
WPK2. I am able to use Internet tools to assist teaching, such as QQ or network platform	0.71
WPK3. I am able to upload the related data to the Internet for students to download, view and study	0.66
Factor 4: Web-Pedagogical-Content Knowledge (WPCK), $\alpha = 0.94$, Mean = 3.75, SD = 0.89	
WPCK1. I am able to select proper existing Web-based courses to assist teaching	0.75
WPCK2. I am able to apply Web technology to using multiple teaching strategies on a particular course unit	0.84
WPCK3. I am able to guide students to use Web resources to study a certain course unit	0.89
WPCK4. I am able to use Web resources to guide students' learning activities for a certain course unit	0.88
WPCK5. I am able to use Web technology to support teaching for the content of a particular course unit	0.84

Overall alpha: 0.94

Total variance explained: 82.72%

(2) *Learning resources (LR)* As adapted from Parker and Loudon's research (2013), LR was added to the questionnaire. Learning resources refer to any materials that facilitate students' learning, such as video resources, case studies, or additional online information that are authoritative.

(3) *Learning content (LC)* As derived from research on teachers' feedback (Parker and Loudon 2013), LC refers to any guidance on students' learning contents after teachers assign the online homework. Teachers would point out inaccurate content and common problems students may confront.

(4) *Learning method (LM)* LM refers to teacher's instruction in helping students to complete quality online homework efficiently. Given the potential hazard students may encounter online, based on the aspect "to exercise self-control" in Internet literary defined in this study, teachers would instruct them to make online learning plan, such as time spent (Javier Murillo and Martinez-Garrido 2013) and learning management (Xu et al. 2014). In addition, some learning methods applicable to traditional homework also apply to online homework. For example, teacher would urge the students to summarize and review their homework regularly, and encourage them to exchange experiences in doing their homework.

(5) *Emotional support (ES)* ES was inspired by Gonida and Cortina's research (2014) which indicates that students' interests are more likely to be heightened if teachers use affirming words and warm praises. It is conceptualized as a necessary part of teacher guidance.

(6) *Internet technology (IT)* IT was in line with Kim and Yang's research (2016). It addressed the need to help students to be technologically competent in sourcing for useful information for productive learning.

(7) *Internet protection (IP)* IP, as discussed in Leung and Lee's study (2012), focuses on protecting children from harms when they use the Internet.

As for the TPACK-W, the study adapted Lee and Tsai's (2010) TPACK-W questionnaire that includes five subscales: Web-general, Web-communicative, Web-Content Knowledge, Web-Pedagogical-Content Knowledge, and Attitude. The reported reliability (Cronbach's alpha) coefficients for these factors were 0.94, 0.96, 0.94, 0.95, and 0.92, respectively, and the overall alpha was 0.96. Our study merged Web-general and Web-communicative into a subscale named Web knowledge and retained five items to assess it to control the length of the questionnaire. In order to establish a distinctive WPK factor, some new items were developed based on teachers' use of Internet for the instructional purpose (see Table 3). The factor pertaining

Table 4 The correlations among the subscales

	Homework requirement	Learning resource	Learning content and method	Internet technology	Internet protection
WK	0.18**	0.20**	0.15*	0.16**	0.19**
WCK	0.15*	0.20**	0.13*	0.19**	0.22***
WPK	0.42***	0.39***	0.42***	0.34***	0.38***
WPCK	0.46***	0.48***	0.49***	0.39***	0.37***

WK web knowledge, *WCK* web-content knowledge, *WPK* web-pedagogical knowledge, *WPCK* web-pedagogical-content knowledge

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

to teachers' attitudes toward Web-based instruction was omitted since it was not directly related to the teachers' knowledge. Nineteen items in the questionnaire were presented.

The items in both of the questionnaires were presented on a 5-point Likert scale ranging from 1, "strongly disagree" to 5, "strongly agree." After three experts in the area of e-learning reviewed the first draft of these two questionnaires, forty teachers were invited to fill in the questionnaires and their feedbacks were solicited. The final versions of the two questionnaires were then confirmed.

Data Analysis

To clarify both the structure of TOHG and TPACK-W, exploratory factor analysis (EFA) was performed separately. The principal component analysis was utilized as the extraction method, along with the rotation method of varimax with Kaiser normalization. Items with factor loading greater than 0.50 were retained. The alpha reliabilities of the scales were generated to check reliability. Correlation and regression analysis were subsequently conducted in order to examine whether TPACK-W factors could predict TOHG. The TPACK-W factors were processed as predictors, and the TOHG factors were regarded as outcome variables.

Results

Exploratory Factor Analysis for TOHG and TPACK-W

As shown in Table 2, a total of 23 items were retained in the final version of the TOHG. Five items with cross-loadings were omitted and five factors were revealed: 'Homework Requirement' (HR), 'Learning Resource' (LR), 'Learning Content and Method' (LCM), 'Internet Technology' (IT), and 'Internet Protection' (IP). Items with a factor loading of at least 0.50 were kept. The total variance explained was 85.41%. The alpha coefficient of these factors was around 0.91–0.97 for each scale, and the overall alpha was 0.98, which indicated satisfactory internal consistency of measuring teachers' online homework guidance. Table 2 presents the results of EFA with the factor means and the standard deviations of TOHG. The factor IP (Mean = 4.10) was scored highest and the factor LCM (Mean = 3.69) was the lowest among five factors. Items of ES could not constitute a factor, HR, LR, IT, and IP remained unchanged, and LC and LM were combined as LCM.

Similarly, EFA of TPACK-W shown in Table 3 revealed that a total of 15 items were retained with four items (4, 5, 13, 14) removed due to cross loading or insufficient loading (<0.5). Nonetheless, the four factors structure was retained, that is 'Web Knowledge' (WK), 'Web-Content Knowledge' (WCK), 'Web-Pedagogical Knowledge' (WPK) and 'Web-Pedagogical-Content Knowledge' (WPCK). These factors accounted for 82.72% of the variance. The Cronbach's alpha coefficients for the four factors were around 0.86–0.96, and the overall alpha was 0.94, which revealed high reliability of these factors, suggesting that the internal consistency was sufficient for statistical analysis. The factor WK (Mean = 4.47) was scored highest and the factor WPCK (Mean = 3.75) was the lowest among four factors.

Correlation Analysis among the Subscales from TOHG and TPACK-W

The Pearson correlation coefficients between the TOHG factors and the TPACK-W factors were calculated to explore the relationship between the teachers' online homework guidance and their technological pedagogical content knowledge about educational use of Web. As shown in Table 4, the five factors of the TOHG were all positively related to the four factors of TPACK-W (from $r = 0.13$ to $r = 0.49$). The correlations coefficients were in the range of weak to moderate. The results of correlation analysis provided initial support for the relationships between TOHG and TPACK-W.

Table 5 Stepwise regression model of predicting the teachers' online homework guidance for TPACK-W (N = 284)

Dependent variables	Predictors	B	S.E.	β	T	R^2
Homework requirement						
	WPCK	0.35	0.08	0.34	4.46***	0.23
	WPK	0.19	0.08	0.17	2.31*	
	Constant	1.80	0.24		7.41***	
Learning resource						
	WPCK	0.49	0.05	0.48	9.12***	0.23
	Constant	1.91	0.21		9.28***	
Learning content and method						
	WPCK	0.51	0.05	0.49	9.49***	0.24
	Constant	1.79	0.21		8.70***	
Internet technology						
	WPCK	0.39	0.06	0.39	7.01***	0.15
	Constant	2.34	0.21		10.95***	
Internet protection						
	WPK	0.24	0.08	0.23	2.93**	0.16
	WPCK	0.20	0.08	0.20	2.56*	
	Constant	2.40	0.24		10.00***	

WPK web-pedagogical Knowledge, *WPCK* web-pedagogical-content knowledge

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Predicting TOHG Using the TPACK-W Factors

The stepwise regression analysis was conducted to build a series of multiple regression models for predicting the TOHG using the Teacher's TPACK-W as predictors. The results are presented in Table 5. The factor 'WPCK' was the common predictor for all the factors in the TOHG which were Homework Requirement ($\beta = 0.34$, $p < 0.001$), Learning Resource ($\beta = 0.4$, $p < 0.001$), Learning Content and Method ($\beta = 0.49$, $p < 0.001$), Internet Technology ($\beta = 0.39$, $p < 0.001$), and Internet Protection ($\beta = 0.20, p < 0.05$). 'WPK' could significantly explain the outcomes of Homework Requirement ($\beta = 0.1$, $p < 0.05$) and Internet Protection ($\beta = 0.23$, $p < 0.01$). It indicated that the teacher's pedagogical experience based on web was very important for teachers to specify their requirements for homework, to guide and protect students when they assigned online homework.

Discussion

The paper developed two questionnaires, TOHG and revised TPACK-W, and explored the relationships between these two questionnaires. Firstly, the questionnaire about the teachers' online homework guidance (TOHG) with five factors demonstrated satisfactory reliability and validity. This indicated that TOHG was an acceptable instrument to assess the teachers' online homework guidance. Our framework initially incorporated seven factors. Five out of seven were successfully maintained through EFA. While most of the previous studies focused on traditional homework and online homework systems, we designed a questionnaire to validate these five factors. The findings built on previous research and contextualized an instrument specifically for online homework. The instrument could assess teachers' guidance for different kinds of online homework, whether be it close-ended or open-ended questions. The current instrument did not make a distinction between the two types of online homework. However, they require different forms of learning: the former is more about acquisition and regurgitation of knowledge, while the latter may involve knowledge construction and online collaboration. The latter is also more closely aligned to 21st century learning. Future research may build on this study to further unpack teachers' online homework guidance. This will refine current understanding about this aspect of teachers TPK.

Although TOHG initially proposed seven subscales, the results showed that the Emotional Support subscale was not extracted from the questionnaire, which may stem from teachers' lack of conscious awareness of offering emotional support for their students. Also it might suggest that more items should be created. There could be a need to interview teachers about whether it is necessary to offer students guidance on emotional support and what to do in more specific way.

In addition, the Learning Content was merged with Learning Method to form Learning Content and Method. This indicated that when teachers assigned students the homework, they integrated learning methods with learning content. This may be a unique form of knowledge that parallels the PCK (Shulman 1987).

The findings indicated that similar to the TPACK framework (see Chai et al. 2013; Mishra and Koehler 2006), teachers' knowledge about online homework involved multidimensional consideration and it is thus complex in nature. Prior to this research, there seems to be no effort in consolidating current understanding about homework for the context of e-learning. This study points out some aspects that teacher educators may need to guide teachers to think of how to give online homework guidance as part of their development to boost e-learning and/or online learning. As the factors represent a form of pedagogical knowledge for online homework that is applicable to all subject matters, they constitute part of the teachers' WPK. The current study extends understanding about technological pedagogical knowledge that it is not a single scale but can be and should be further contextualized to specific technology and specific activities (i.e., online homework) (see Chai et al. 2012, 2016). Such unpacking is necessary for further theory building of TPACK literature (Koehler et al. 2014).

The paper also revised a questionnaire TPACK-W (Lee and Tsai 2010) which had satisfactory validity and reliability measures. This study successfully established that WPK can be an identifiable and distinctive factor. This identifiable WPK provides support that the TPACK framework can be operationalized. However, we would like to highlight that as the TPACK framework is gaining attention and is utilized in teachers' design work, discussed in conferences and courses associated with educational technology, teachers and teacher educators are likely to develop more improved understanding about the framework and thus emerging researches are more able to replicate the TPACK factors (see Chai et al. 2016).

The findings indicated WPCK can predict all the five factors of TOHG. As argued earlier, online homework is a follow-up teaching activity that is heavily dependent on the web-based instruction for the subject matter. The findings verified that the theoretical relationship between TPACK-W and TOHG was as we had conjectured. The findings extended current understanding of TPACK research by adding consequential variables that were influenced by the TPACK. Most TPACK research to date uses the TPACK as the dependent factor, while some attention has been devoted to investigating if the TPACK survey can predict teachers' lesson planning quality (see Kopcha et al. 2014). This study indicates that teachers' TOHG may also be influenced and this finding seemingly has not been reported. Closer examination of the regression indicates that WPCK is a more influential factor than WPK. The finding seems to be reasonable since teachers' formulation of homework is necessarily involving specific content knowledge that the homework is designed for.

WPK, on the other hand, predicts only the homework requirement and Internet protection. The outcome is also consistent with the original design of the subscales since these two factors are applicable to online homework in general, while the other three factors (Learning Content and Method, Learning resources, and Internet Technology which are about sourcing for information) are more associated with content knowledge. The findings are in general consistent with Chai et al.'s (2012) finding. Similarly, factors influencing teachers' understanding and formulation of homework have not identified significant technology-related predictors thus far. This study has identified WPK as possible antecedent for teachers' online homework guidance. It should be also noted that other factors, such as WK or WCK, are not significant factors in predicting teachers' online homework guidance by the regression analysis. WPCK, probably with WPK, can, to a certain extent, well explain teachers' usage of online homework guidance. More methods for fostering teachers' WPCK and/or WPK may be essential for developing their competence as well as better usage for online homework guidance.

Limitation and Future Study

This study had some limitations. Firstly, the data collected were self-report data. Although the factorial validity and reliability were acceptable, the findings were not enriched with qualitative data of teachers' online instructions and their lesson plans. Deeper insights could be derived if such data were included. Secondly, all of the participants in this study were all from China. Different countries and cultural contexts frame educational environments and thus their associated practices are different. The findings may not be generalizable to other places. Similar studies are encouraged in other countries to validate the conclusions.

The results demonstrated the significant relationships between the teachers' online homework guidance and the teachers' technological pedagogical content knowledge about educational use of Web. Besides, the exploration needs to be carried out about the relationships between teachers' online homework guidance and teachers' other features, such as teachers' Internet attitude, teachers' Internet self-efficacy, or their pedagogical beliefs to gain a fuller picture for the issue.

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