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REGULAR ARTICLE

Exploring Singaporean Chinese Language Teachers' Technological Pedagogical Content Knowledge and its Relationship to the Teachers' Pedagogical Beliefs

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Abstract The notion of technological pedagogical content knowledge (TPACK) has recently emerged as a key theoretical framework that could help explain the complexity involved when teachers integrate ICT into classroom teaching. While the framework has been employed in hundreds of published studies, surveys of teachers' TPACK for specific subject matter, especially for language teaching, has been rare. In addition, there is also a lack of studies about the relationship between teachers' TPACK and teachers' beliefs. This study investigates the profile of Singaporean Chinese language teachers' technological pedagogical content knowledge (TPACK) and their pedagogical beliefs. It first validated an adapted questionnaire entitled "Technological Pedagogical Chinese Language Knowledge". Based on the data collected from the questionnaire, the findings reveal that the teachers rated themselves as most competent in content knowledge but least competent in TPACK. The qualitative findings provide further support on the teachers' self-rated profile. The relationship between Teachers' TPACK and how it is related to teachers' constructivist or traditional pedagogical beliefs are investigated through Pearson's correlation. The findings suggest that teachers' TPACK is more related to the teachers' constructivist pedagogical beliefs than to the traditional beliefs. Implications of the current study in terms of Chinese language teachers' professional development are discussed.

Keywords
Technological Pedagogical Content Knowledge · ICT · Chinese language

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Introduction

The rapid advancements of Information and Communications Technology (ICT) have perturbed education systems all over the world in many ways. Many affordances of ICT can be adapted to engender active learning, collaborative learning, and knowledge construction, i.e., constructivist-oriented learning (Howland et al. 2012). However, despite decades of education reform, constructivist-oriented learning with ICT integration remains an elusive goal (for example, see Bain and Weston 2012; Prestridge 2012). The lack of theories to facilitate productive conversation and knowledge creation among researchers to address constructivist-oriented ICT integration is a major factor contributing to the lack of progress (Graham 2011). The theoretical framework of technological pedagogical content knowledge (TPACK, sometimes also refer to as TPCK; see Thompson and Mishra 2007) has emerged as a possible solution to resolve some of these problems as it outlines the various types of knowledge that teachers need in order to integrate ICT effectively. Two recent reviews (Chai et al., in press; Voogt et al. 2012) have indicated that the TPACK framework is gaining popularity among teacher educators of educational technology, with hundreds of research papers being published. However, the two published reviews also indicate that surveys for teacher's self-assessment of their TPACK profile and the application of TPACK for language teaching as two obvious gaps in research that need to be addressed. Even though teachers may possess knowledge for ICT integration, teachers' beliefs have been identified as a key mediator of teachers' practice as it impacts their willingness to change (Ertmer 2005; Lim and Chai 2008; Petko 2012; Windschitl 2002). Yet, how teachers' TPACK is related to their beliefs has also been identified as a knowledge gap in current TPACK

research (Graham 2011). To address these gaps, this paper seeks first to investigate Chinese language teachers' TPACK through an adapted survey instrument, and secondly to analyze how this is related to their pedagogical beliefs. The study reported here is able to identify all seven factors of TPACK specifically for Chinese language teaching and also the two factors of pedagogical beliefs being measured. In addition, it establishes the correlation between teachers' pedagogical beliefs and their TPACK, thereby addressing the research gaps mentioned above.

Literature Review

The TPACK framework comprises seven types of teacher knowledge. The fundamental forms of knowledge are content knowledge (CK) as in the subject matter knowledge within a discipline; pedagogical knowledge (PK) about students' development and psychology, classroom management skills, and teaching strategies; and technological knowledge (TK) about how to handle and work on computer software and hardware. Mishra and Koehler (2006) represented these three forms of knowledge (TK, PK, and CK) as overlapping circles in a Venn diagram. Four other forms of knowledge can be derived from the overlapping areas among TK, PK, and CK. These are pedagogical content knowledge (PCK), technological content knowledge (TCK); technological pedagogical knowledge (TPK) and finally TPACK. PCK refers to the unique form of teacher's knowledge that transforms their subject matter understanding through pedagogical reasoning such that it is accessible to the targeted students. Shulman (1987) developed the notion of PCK and regarded it as the knowledge base for teaching. TCK refers to technological representation of content knowledge created not for pedagogical purposes but for the subject matter (Cox and Graham 2009). An example of TCK would be modeling software used by scientists to predict phenomena. On the other hand, TPK refers to pedagogically sound ways of using technology without specific references to the content of study. The notion of Webquest (Dodge 2001) is a good example of TPK, since it is a framework to guide students' inquiry on the web and it can be employed for many different subject matters. Finally, TPACK is regarded as the contextualized and situated synthesis of teacher knowledge that manifests itself in ICT-integrated lessons. The framework hypothesizes implicitly that teachers' TPACK can be either derived through the synthesis of TK, CK, and PK; or from the synthesis of TCK, PCK, and TPK.

The TPACK framework has been mostly used to design and evaluate teacher education programs for both preservice and inservice teachers and most published literature has indicated positive growth among the teachers (see Mishra and Koehler 2006; Angeli and Valanides 2009; Tee and Lee 2011). The potential for the framework to be employed in educational technology development, policy analysis, and needs analysis has been recognized and identified as future research areas (Chai et al., in press; Voogt et al. 2012). In addition, Chai et al. and Voogt et al. have both pointed out that subject-specific TPACK studies involving interventions have been confined largely to the areas of Science (see for example Jimoyiannis 2010; Khan 2011), Mathematics (Niess 2007), and Social Studies (Manfra and Hammond 2008). Interestingly, empirical studies of the use of ICT employing the TPACK framework for language learning are rare. Given that many emerging technological products such as blogging and podcast can potentially offer many opportunities for authentic language learning, investigating ICT integration for language education through the TPACK framework could help identify ways of enhancing language teachers' ability to use ICT.

The emerging importance of the TPACK framework has prompted many researchers to create questionnaires to survey teachers' perception of their TPACK profiles. Creating valid and reliable surveys of teachers' self-reported efficacy of TPACK can serve as instruments for teacher educators to perform needs analysis. It can also be a means of course evaluation, especially for large cohort of students. However, many published articles in this area have performed the factor analysis with a single dimension at a time (Schmidt et al. 2009; Sahin 2011). When the seven dimensions of TPACK are factor analyzed simultaneously, merging of factors was commonly reported (see Archambault and Barnett 2010; Lee and Tsai 2010; Koh et al. 2010). Given that the TPACK framework proposes that four constructs are derived from the three fundamental forms of knowledge, Cox and Graham (2009) suggested that it is important to delimit the boundaries of each construct clearly so that measurement problems during survey development can be avoided (Graham 2011). A recent survey created by Chai et al. (2011) has been able to isolate all seven TPACK factors through both exploratory and confirmatory factor analyses with all yielding good alpha reliabilities ($\alpha > 0.83$). However, the survey was not created for specific subject domains and references to CK-related items were generally stated as the respondent's first and second teaching subjects. As a result, an additional CK-related factor comprising of items measuring the teacher's second teaching subject emerged. This causes some problems as other content-related factors (TCK and PCK) were also created to measure the two CK areas but they did not split into two factors. As such, interpretation of the teachers' TCK and PCK becomes problematic especially when the teachers are teaching different subjects (e.g., Mathematics and English). Ideally, TPACK surveys should focus on a specific content area so that

ambiguities related to the interpretation of results are reduced. Chai et al. (in press) has suggested that a future direction of creating TPACK survey is to contextualize the survey for specific TK (e.g., Web-based environment, see Lee and Tsai 2010); PK (e.g., inquiry-based learning) and CK (e.g., for Science or Mathematics). An appropriate level of contextualization is likely to help resolve the problem of merging of factors as the distinctiveness of each factor will become more salient to the respondents. Findings generated through such surveys would also have more direct implications for specific teaching contexts. To date, content-specific TPACK surveys are confined to Science (see Graham et al. 2009; Lin et al., 2012). We were unable to identify TPACK surveys that focus on language teaching. This study will therefore formulate a TPACK survey specifically for Chinese language teachers by adapting from currently validated TPACK surveys.

Another issue raised by researchers with regards to the TPACK research is about the relationships between TPACK and teachers' beliefs (Angeli and Valanides 2009; Voogt et al. 2012). Teacher's beliefs have been identified both as a facilitator and an inhibitor for teachers' use of technology (Ertmer 2005). Studies of teacher's pedagogical beliefs typically categorize teachers' beliefs as being situated along a continuum of traditional/teacher-centered beliefs and constructivist/student-centered beliefs (Samuelowicz and Bain 2001; Sang et al. 2009). Traditional/teacher-centric beliefs (TB) see teaching as mainly the transmission of subject matter knowledge and learning as the acquisition and accumulation of transmitted knowledge. Constructivist/student-centric beliefs view teaching as a process of facilitating students' effort in making sense of the subject matter. Teacher's pedagogical beliefs have also been associated with their espoused use of ICT. Generally, these studies indicate that teachers who are inclined towards constructivist pedagogical beliefs tend to also believe in the use of ICT to support of students' sense-making (Judson 2006). However, there is evidence that constructivist-oriented teachers do support the traditional use of ICT (Chai 2010). As teachers are concerned with the pragmatics of teaching rather than theoretical consistency, these results should not be regarded as contradictory. This is because teachers with traditional pedagogical beliefs tend to be engaged in traditional uses of ICT, which emphasizes teachers' presentation supported by online drill-and-practice (ibid). It is important to understand the kinds of TPACK that are more strongly associated with teachers' constructivist-oriented beliefs. This has important implications for practice as the TPACK framework is increasingly being adopted to guide the planning of ICT curriculums in teacher education (see Mishra and Koehler 2006; Angeli and Valanides 2009, Tee and Lee 2011). Therefore, after analyzing the TPACK of Chinese language teachers with an adapted survey, this study will also examine how their TPACK profiles are related to their pedagogical beliefs.

Method

Research Questions

Based on the gaps identified in the literature review, the research questions formulated are as follow:

1. Is the adapted survey a valid and reliable instrument to measure Singaporean Chinese teachers' TPACK and their pedagogical beliefs?
2. What is the profile of Singaporean Chinese teachers' TPACK and their pedagogical beliefs?
3. What are the relationships between the teachers' TPACK and their pedagogical beliefs?

Participants

The participants of this study were 349 inservice Chinese teachers who were attending courses in the Singapore Center for Chinese Language in June 2012. They were invited to take part in an online survey through their course lecturers. Participation was totally voluntary with no bearing towards their course grades. A total of 287 teachers responded, resulting in a response rate of 82.23 %. Their mean age was 36.6 (SD = 8.4). One hundred and thirty two of them were primary school teachers (46 %), while 155 (54 %) were secondary teachers.

Instrument

The instrument administered on the respondents comprised two sections. The section for the TPACK constructs was adapted from Chai et al.'s (2011) survey while the section to measure teachers' beliefs comprised items selected from Teo and Chai's (2008) survey. For the TPACK portion, all content-related items (including CK, PCK, TCK, and TPACK) were specified as Chinese language. Additional items were created for PCK (5 items) and TCK (2 items) because the respective factors in Chai et al.'s (2011) survey had only two items relevant for the content area that the teachers are teaching. Also, given Singapore's current emphasis on collaborative and self-directed learning supported with technology (see Teo and Ting 2010), the TK items were changed to measure teacher's knowledge of web-based technology that supported collaborative and self-directed learning. The TPACK items were also re-crafted to reflect teachers' perception of their abilities in

designing web-based collaborative and self-directed learning of the Chinese language. These adaptations made the survey substantially different from Chai et al.'s (2011) survey. These items were therefore considered to be measuring Technological Pedagogical Chinese Language Knowledge (TPCLK). The TPCLK items were designed to be focused on constructivist-oriented instruction. For the teacher's beliefs items, four items each for constructivist beliefs and traditional beliefs were selected from the instrument reported in Teo and Chai (2008). Not all the items reported in Teo and Chai were used as we wanted to avoid survey fatigue. The items were selected based on their clarity in terms of describing the respective beliefs as well as the consistency of their internal reliability across different survey administrations. We named this part of the survey as Teacher Pedagogical Belief (TPB) survey. A total of 45 items were assembled and they were subsequently translated by two professors majoring in Chinese language. The translated instrument was further verified by a third professor who is also a Chinese language expert and who is knowledgeable about TPACK. In addition, an open-ended question about the teachers' experience of teaching with ICT was provided to collect teachers' viewpoints. The open-ended question was created to provide data for a deeper understanding of the issues involving teachers' beliefs and their teaching practices. However, as there is only one open-ended question and less than half of the teachers responded, the data is still considered as supplementary in nature.

Data Analysis

As the instrument was contextualized and adapted from a previously validated instrument, it is necessary to examine if the construct validity still holds. Confirmatory factor analysis using AMOS 20 was conducted. After removing items that exhibit multicollinearity properties and those with insufficient loading (<0.5), the alpha reliabilities and the mean scores of the factors with the remaining items were computed to answer Research Questions 1 and 2. To answer Research Question 3, Pearson correlations were performed to investigate the relationships between the teachers' TPACK and their pedagogical beliefs.

One hundred and twelve teachers responded with verbal data, which ranged from one sentence reply to several paragraphs. On average, these teachers wrote 3.8 sentences in response to the open-ended questions. Qualitative coding through the constant comparative method (Strauss and Corbin 1990) was performed on the open-ended survey question. Open coding was performed first followed by axial coding where the codes were categorized. Through iterative coding, the first author developed the coding schemes. The four categorical codes and associated open codes developed include ICT tools (e.g., school portal, Powerpoint), barriers for using ICT tools (e.g., time, technical problems); teaching activities (e.g., peer evaluation, drill-and-practice, oral practice); and teachers' beliefs (e.g., ICT ineffective, students' interest). Another researcher recoded the data applying the coding schemes developed. The inter-rater agreement was 75 % and the differences were resolved through negotiation. The researchers then derived the themes through exploring the relationships between the categories and the codes. For example, we explore how the teachers made use of the ICT tools to support the teaching activities and how teachers' beliefs about ICT prevented the teachers from using ICT. The outcomes are reported and discussed as part of Research Question 2.

Findings and Discussion

The findings and discussion below is reported in the sequence of the research questions asked.

Validating the TPCLK and TPB Concurrently

First, the CFA yielded nine factors as what we have hypothesized. Seven items that exhibited mutlicollinearlity and insufficient loading were removed. These items were PK5, TCK3, PCK1, 2, and 7; TPK1 and CB3. The remaining 38 items retained for the nine factors are shown in Table 1 below. The nine factor structure yielded a series of fit indices that provide support for the construct validity of the instrument ($\chi^2 = 1379.4$, df = 629, $p < 0.001$, χ^2/df = 2.19, TLI = 0.91, CFI = .92, RMSEA = 0.065). According to Hair et al. (2010), the model can be accepted. The overall alpha reliability of the nine factors is 0.93. Alpha reliabilities for the factors are reported in Table 1. The findings provide support that the adapted TPCLK with TPB possess satisfactory construct validity and reliability for the assessment of Chinese language teacher's TPACK and pedagogical beliefs.

Building on the foundation of Chai et al.'s (2011) instrument, supplemented with careful consideration of Cox and Graham's (2009) suggestions about how the TPACK factors should be demarcated; this study has further contextualized a TPACK survey that is specifically meant for Chinese language teachers. The validation of the TPCLK together with TPB surveys may allow other researchers to examine their Chinese teacher's TPCLK and pedagogical beliefs. Teacher educators promoting ICT use among preservice or inservice teachers teaching Chinese language can use the instrument to assess teachers' TPCLK and TPB both for needs assessment and course evaluation. Needs analysis allows the teacher educators to target

Table 1 Factors and Item Loadings of TPCLK and TPB

Factors	Items	Standardized validity coefficient	Cronbach's alpha reliability	Mean (SD)
TCK1	I am able to use software designed specifically for Chinese language (e.g., electronic dictionary, corpus, educational websites for Chinese language)	.70	.86	5.07 (1.08)
TCK2	I know the technology needed for the research of Chinese language (e.g., corpus technology, digital voice recorder, electronic databases)	.85		
TCK4	I am able to use the professional software to perform research related to Chinese language	.90		
TPACK1	I can formulate in-depth discussion topics about the Chinese language and facilitate students' online collaboration with appropriate tools. (e.g., Google Sites, Discussion Forum)	.84	.94	5.04 (.99)
TPACK2	I can set authentic problems related to Chinese language topic and present them through the computers to engage my students	.84		
TPACK5	I can facilitate students' construction of Chinese language knowledge using appropriate technologies according to the requirements of syllabi (e.g.,web-based mind-mapping tool, WIKIs)	.83		
TPACK4	I can create computer-supported self-directed learning activities specifically for the Chinese Language learning(e.g., using Blog, Webquest)	.87		
TPACK3	I can design inquiry-based learning supported by appropriate technologies(e.g., online forums, web-based resources)to guide students in understanding knowledge related to the Chinese language	.87		
TPACK6	I can design student-centered learning that integrates knowledge of Chinese language, technologies and pedagogies	.84		
PCK3	Without using technology, I can help my students to understand the content knowledge of Chinese language through various ways	.91	.94	
PCK4	Without using technology, I can address the common learning difficulties my students have for Chinese language	.91		
PCK5	Without using technology, I can facilitate meaningful discussion about the Chinese language content students are learning	.92		5.54 (.86)
PCK6	Without using technology, I can engage students in solving real world problem related to Chinese language	.86		
PCK8	Without using technology, I can support students to manage their learning of Chinese language	.74		
TPK2	I am able to facilitate my students to use technology to find more information on their own	.71	.92	5.35 (.90)
TPK3	I am able to facilitate my students to use technology to plan and monitor their own learning	.91		
TPK4	I am able to facilitate my students to use technology to construct different forms of knowledge representation	.94		
TPK5	I am able to facilitate my students to collaborate with each other using technology	.87		
CK4	I am confident to teach Chinese language	.88	.86	5.66 (.77)
CK3	I am able to gain deeper understanding about the content of Chinese language on my own	.77		
CK2	I can think about the content of Chinese language like a subject matter expert	.67		
CK1	I have sufficient knowledge about Chinese language	.83		
PK4	I am able to help my students to reflect on their learning strategies	.88	.91	5.59 (.65)
PK3	I am able to help my students to monitor their own learning	.89		
PK2	I am able to guide my students to adopt appropriate learning strategies	.89		
PK1	I am able to stretch my students' thinking by creating challenging tasks for them	.74		
PK6	I am able to guide my students to discuss effectively during group work	.67		
TK4	I am able to use a range of online tools (e.g., Wallwisher, web-based mind-mapping tools, Podcast etc.)	.84	.90	5.44 (1.07)
TK3	I am able to use collaboration tools (e.g., Google Sites, Google Doc)	.78		
TK2	I am able to use communication tools (Yahoo, IM, MSN Messenger, ICQ, Skype etc.)	.84		
TK1	I am able to use social media (e.g., Blog, Wiki, Facebook)	.89		
CB4	A good classroom is one that promotes student's knowledge construction through active thinking	.81	.89	
CB2	Teaching should be flexible to suit student's individual differences	.93		6.24 (.67)
CB1	Teachers should encourage students to inquire, discuss and articulate their views	.83		
TB4	The authoritative way of instruction is the best for classroom teaching	.83	.86	4.52 (1.27)
TB3	Teacher should have total control over student's learning processes	.86		
TB2	The main way to learn is through drill-and-practice	.72		
TB1	The teacher's job is mainly to transmit knowledge to students	.70		

professional development activities towards the knowledge or beliefs where the teachers have obvious needs, while course evaluation allows the teacher educators to gain information about course effectiveness for promoting TPACK and change in beliefs.

In addition, we believe that the instrument can be easily adapted to other languages by substituting Chinese language with other targeted languages. In addition, given that Lin et al.'s (2012) research also validated Chai et al's (2011) instrument for science teachers, the basic structure of these instruments may provide good basis for other researchers to further contextualize the TPACK surveys for other content areas such as mathematics, history, geography, etc. However, as the instrument is validated mainly with a Singaporean sample, cross cultural issues may arise when the survey is applied elsewhere, especially in the West. As past research have indicated that TPACK surveys could easily suffer from the problem of merged factors (Archambault and Barnett 2010; Lee and Tsai 2010; Koh et al. 2010), further validation is necessary.

The Profile of Singapore Chinese Language Teachers' TPCLK and Beliefs (Quantitative)

To answer Research Question 2, Table 1 provides the mean scores and standard deviations for each factors measured. In terms of the teachers' TPACK profile, it shows that the teachers perceived themselves strongest in term of their CK ($M = 5.66$, SD $= 0.77$) and weakest in terms of their TPACK ($M = 5.04$, SD $= 0.99$). The second lowest mean score was for the TCK ($M = 5.07$, SD $= 1.08$). The technology-related factors (TK, TPK, TCK, TPACK) were generally lower than the non-technology-related factors (CK, PK, PCK), with the highest rating given to technological knowledge of how to use Web 2.0 tools ($M = 5.44$, SD $= 1.07$).

The profile we obtained through the quantitative survey indicates the teachers to be only slightly positive about their knowledge and ability to design ICT-integrated lessons while they are more positive about their understanding of more traditional forms of teachers' knowledge as described by Shulman's PCK (1987) framework. Such a TPACK profile fitted our expectations about Singaporean teachers. With 15 years of promoting ICT in education through Singapore's ICT Masterplans (see Teo and Ting 2010), Singapore teachers are generally familiar with the use of ICT and they have accumulated some technology-related knowledge and experience of integrating ICT. However, it is also true that ICT may still be peripheral to mainstream teaching. Professional development targeted at helping the teachers to enhance their technology-related knowledge and subsequently drawing upon this knowledge to create ICT-integrated lessons is necessary. More importantly, given the emergence of a myriad ICT tools that have substantial pedagogical affordances such as the Web 2.0 tools for students' collaborative knowledge construction (see for example Howland et al. 2012), the amount of professional development needed would be quite substantial as each ICT tools engender different forms of teaching and learning for different subject matter. More effort in providing teacher professional development, especially in helping teachers to create the needed TPACK themselves (Chai et al. in press), is therefore advocated.

Our study also supports Graham's (2011) observation that TCK is an area that needs attention. In particular, the findings would suggest that teacher educators need to model how TCK can be tapped upon using a constructivist-oriented pedagogy. Reflection and translation of how teachers perform research about Chinese language using technology should be conducted to see how such processes can be taught among students so that the students learn how to construct useful language knowledge themselves. For example, the processes in which teachers assemble examples of sentences from online dictionaries that demonstrate how certain vocabularies are used, and how they then study adjacent words to understand the underlying grammatical principles, could be taught to the students. Such sense-making activities would be essentially constructivist-oriented. It would imply that the teachers need both the tools and the associated pedagogical beliefs to design such learning activities.

In terms of the teachers' pedagogical beliefs, the teachers expressed highly constructivist-oriented pedagogical beliefs ($M = 6.24$), while they were just slightly agreeable towards traditional teacher centric beliefs ($M = 4.52$). Such profile seems to fit Jacobson et al.'s (2010) study of Singaporean teachers' beliefs and use of ICT, which reflect a mixed of teacher-centric and learner-centered approaches. If technology promotes constructivist pedagogy as postulated (Judson 2006), the TPACK profile and the belief profile would imply that the teachers had the desire to help students in meaning-making but they may not have sufficient knowledge to implement such instruction efficiently and effectively. This again points to the need for ongoing professional development. A way forward would be to formulate instructional design guides to help teachers to problematize their existing PK, CK, and PCK, which appeared to be stronger, and to enhance their practice with relevant TK, TCK, or TPK. Harris et al. (2009)worked on articulating lesson activity types and suggested possible technological enhancements that could be included. This seems to be a promising approach.

The Profile of Singapore Chinese Language Teachers' TPCLK and Beliefs (Qualitative)

One hundred and twelve (39.4 %) teachers provided inputs via the online open-ended question that asked the teachers

to describe their experience in the use of ICT. The two broad themes we identified are reported below.

First, the Chinese teachers mostly expressed positive beliefs about ICT and they are likely to enact mixed pedagogical practices with slightly more emphasis towards traditional teaching. An emerging practice based on the social constructivist notion of learning was reflected. Our data indicated that more teachers believed that "ICT is useful in teaching and learning" (26 comments) especially for promoting students' interest with a minority (5 comments) expressing that "teaching without technology may actually be the most effective." In addition, many teachers reported using a range of ICT tools (Powerpoint, school portal, blog, discussion forum, Facebook). Based on associated reports of the teaching activities (show-and-tell, online oral and drill-and-practices), the use of ICT tools was likely to be more geared towards traditional teaching practice aiming at knowledge acquisition. A representative response was "Audacity for online oral practice and online oral exam (internal); Google documents for survey and feedback; Ask-and-learn for online learning assignments; Boshi wang for online learning assignments and online teaching (www.boshi100.com)". Except for Google documents which seemed to facilitate administrative purpose, the other three ICT tools were used for language practices apparently to prepare students for examination.

However, some teachers also reported the use of social media (blog, Facebook, Youtube, Wikis, Google sites and documents) and online discussion forums or mind-mapping tools to engage students in collaborative learning, typically targeted at enhancing students' ability to interact. An example of a teacher's response was "Students are engaged and are enthusiastic about learning. Using Google spreadsheet, students are engaged in group discussions and are able to share their ideas/opinions/views with their peers, allowing for peer evaluation, which allowed them to build on their existing knowledge."

Secondly, the teachers reported a number of challenges they faced in using ICT. These included the insufficient time for preparation, students' off-task behaviors, technical problems, and less than desired outcomes. For example, one teacher wrote "A major problem faced is the teacher's fear of using ICT and fear of IT problems arising during lessons. Resources such as hardware and time issue are major problems hindering teachers in the use of ICT during lessons." A few teachers pointed a specific problem that Chinese language teacher face was "the Chinese input, as some students are weak in Hanyu Pinyin (authors' note: Hanyu Pinyin a phonetic based input system for Chinese language)."

The qualitative findings provided some support to the quantitative data we obtained in that generally, the survey indicated that the teachers' were weakest in terms of the constructivist-oriented TPACK construct, which is a highly synthesized form of situated knowledge (Mishra and Koehler 2006). The qualitative data is congruent with the quantitative data in that the teachers' reported practice was less geared towards constructivist lessons and they faced multiple challenges. In addition, the description we obtained was to be expected given the prerogatives of current ICT masterplan (Teo and Ting 2010) which emphasized the constructivist-oriented use of ICT. Given such policy and associated professional development, one would expect to see an emerging practice towards constructivist-oriented use of ICT. This emerging mixed practice also seemed to be consistent with earlier research based in Singapore (Lim and Chai 2008) and elsewhere in the world (Petko 2012). In addition, while there was an increased use of ICT, teachers continue to face multiple challenges ranging from barriers associated with time, skills, and resources (Ertmer 2005). However, Ertmer's (2005) assertion that beliefs may be the last frontier could be challenged here. The teachers expressed mainly positive beliefs about ICT and they were highly oriented towards the constructivist's beliefs. What they may lack could be the design competency which has been elaborated by Tsai and Chai (2012).

In summary, both the quantitative and qualitative data suggested that Singaporean Chinese teachers possess some knowledge about ICT integration and they employed both teacher-centric and learner-centered pedagogies. The latter posed some additional demands on the teachers' time to develop the expertise needed to design and facilitate the lessons. It also demands that students be familiar with Chinese language input systems. This is not surprising as Windschitl (2002) has pointed out that implementing constructivist-oriented instruction created multiple demands on teachers' expertise, in particular their pedagogical expertise. This study indicates that similar demands may also be imposed on students, which is a rarely research area. Chai et al (in press) have pointed out that while teachers need to develop TPACK for ICT integration, students also need to develop the corresponding conception of learning for specific subject matter within certain technological environment. This is associated to the cultural change needed, as proposed by Windschitl (2002), as a condition for the widespread adoption of constructivist-oriented learning to occur. In other words, other than TPACK research on teachers, we need to investigate the technological-based expertise in the learning of content knowledge (TLCK) for students. TLCK is important for the development of twenty-first century life-long learning skills and media literacy. Students who possess strong TLCK would be able to exploit the affordances of technology to learn.

Table 2 Correlations among the TPACK and TEB factors

	TPK	TCK	TPACK	CK	PK	PCK	TK	TB	CB
TPK	1								
TCK	.70**	1							
TPACK	.78**	.77**	1						
CK	.26**	.25**	.21**	1					
PK	.37**	.32**	.31**	.61**	1				
PCK	.17**	.11	.10	.30**	.38**	1			
TK	.71**	.60**	.63**	.34**	.33**	.21**	1		
TB	.09	.13*	.10	.06	.03	.11	.04	1	
CB	.34**	.24**	.27**	.34**	.29**	.19**	.33**	−.06	1

* $P < .05$, ** $P < .01$

The Correlations Between TPACK and TEB

Research Question 3 was explored through Pearson correlations. As shown in the Table 2, the relationships between TPACK associated factors were similar to those reported by Chai et al. (2011) in that almost all the factors were significantly associated with each other except for the relationships between PCK and TK, TCK and TPACK. This was a reasonable relationship as PCK items were preceded with the opening of "Without using technology". In addition, the constructivist-oriented pedagogical beliefs (CB) were significantly associated with all TPACK factors while the traditional belief (TB) was only associated weakly with TCK.

This study adds to current literature by providing an initial indication that TPACK factors and teachers' beliefs are associated; and the general pattern of association is with constructivist-oriented beliefs, which is consistent with earlier research finding (Chai 2010; Judson 2006; Petko 2012). The findings address the current gap pointed out by a number of researchers (Angeli and Valanides 2009; Voogt et al. 2012). The magnitude of correlations of CB and TPACK factors suggest that the linkages between teachers' perception of CB and their efficacy of constructivist-oriented ICT practices still need to be strengthened. The study results indicated that while teachers were generally positive about embracing constructivist beliefs, they could still need more professional development to translate these beliefs into concrete ways of practicing ICT integration. These results point to the importance of further investigation into the relationships between TPACK and teachers' beliefs. Future research may need to probe deeper into how knowledge and the belief factors interact, which may be a stronger predictor for teacher's contextual use of ICT.

In addition, the teachers' TCK and its relationship with the teacher's beliefs is worthy of further explication. While TCK is more strongly associated with CB, it is also significantly associated with TB. The reason that TCK is associated with traditional beliefs could be that currently, the use of electronic dictionary (a form of TCK for language subject represented in TCK1) is most importantly featured in students' Chinese language examination. In Singapore, all students taking Chinese language composition examination are allowed to carry specific electronic dictionaries to assist them. In addition, the TCK items we designed reflect the use of technology for content-based research. The teachers may undertake this task for the purpose of transmitting accurate language knowledge to students, such as performing research about how phrases or vocabularies should be used in grammatically correct ways through online corpus. As a construct, TCK should be represented without any pedagogical elements (see Cox and Graham 2009). In itself, it could serve either constructivist or traditional teaching practice. Qualitative interviews on TCK and teachers' traditional beliefs are needed to help shed light on this matter.

Conclusion

This study has formulated and validated a survey instrument for teachers' self-report of their TPLCK and pedagogical beliefs. According to our review (see also Chai et al., in press), this is the first survey research from the TPACK framework on Chinese language teachers. Future research on other languages could be conducted through adapting this survey. This study has also provided an initial profiling of Singaporean Chinese language teachers' TPACK and their pedagogical beliefs. It can inform teacher educators and the Ministry of Education of the teachers' professional development needs. The survey could also serve as one of the instruments for pre-and-post course evaluation to see if the designed courses meet teachers' needs. This should be a focus of future research. Professional development, as all teacher educators would advocate, is the key to reform. For national level reform, surveys of this nature are essential. Finally, this study has documented an initial investigation between TPACK and teachers' beliefs. Teachers' beliefs are represented in many forms for different purposes. More

thorough research employing structural equation modeling and other forms of surveys of teachers' beliefs (e.g., teachers' epistemic beliefs) are necessary. In-depth interviews with teachers about their beliefs, knowledge and practices, supplemented by classroom observations, would address the limitations of the current study in providing deeper insights of the complex relationships among these constructs.

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