

Reliability and Validity of TPACK Instruments in EFL

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Abstract: In this study, issues of validity and reliability of a wide range of instruments used to measure technological pedagogical content knowledge level of English teachers were discussed. To this end, the search in the databases of ERIC, ScienceDirect, Scopus, EBSCOhost, and Web of Science was conducted. As a result of applying a set of criteria to publications retrieved from the databases, 60 studies (including 40 articles, 14 dissertations and 6 conference papers) were found suitable for analysis in the current study. A two-level analysis was conducted. First one was study-level analysis focusing on general characteristics of each study and the second one was an instrument-level analysis that focuses on target audience and research instruments. As a consequence of the analysis at the study-level, 128 instruments were classified into five types of instruments including, open-ended questionnaire, observation, performance assessment, interview, and self-report instruments. At the instrument-level analysis, issues of validity and reliability of those instruments and target audience were investigated. The findings revealed that 60% of the reviewed studies did not provide any index of reliability, and similarly over 80% of the studies presented no evidence of validity.

1. INTRODUCTION

The advances of innovative technology have paved the way for the emergence of the concept of educational technology. Educational technology is fundamentally composed of some components that are constantly interrelated to each other. The design and development of educational content is closely related to its employment and management. Besides, one of the indispensable and crucial components of this process is the assessment of educational content in terms of both students' learning efficiency and effectiveness of materials (Luppigini, 2005). Educational technology has been the focus of different stakeholders' attention in education since there have been great efforts of nations to pursue the integration of technology with education approaches (Chai et al., 2013). Despite the technological developments, there are some concerns among some scholars whether teachers could use technological tools as they are meant to instead of merely supporting traditionally oriented teaching (Agyei & Voogt, 2012; Shin et al., 2009; Sessoms, 2008). At this point, in order to assess how teachers are able to integrate their knowledge of content, pedagogy and technology, technological pedagogical content knowledge (TPACK, hereafter) steps in (Koehler & Mishra, 2009; Koh et al., 2013; Schmidt et al., 2009).

TPACK contains three mutually interconnected knowledge domains. These domains are called

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as content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK) where teachers are supposed to integrate their content, pedagogy, and technology knowledge into their teaching process to accomplish efficient and effective learning process on students' parts (Drajati et al., 2018). Technology Knowledge (TK) is simply defined as the knowledge of operating computer software and hardware and employment of a range of software like presentation slides, spreadsheet program, word processors, and some tools for communication. Moreover, teachers are expected to have the ability to run above-mentioned tools and technologies, and use them effectively in the process of teaching (Chai et al., 2010; Mishra & Koehler, 2006, 2008). Content Knowledge (CK) refers to knowledge of teachers' subject area where they are supposed to have a good command of expressing and explaining fundamental facts of the content knowledge, concepts, theories, and protocols. Furthermore, they are expected to have the ability to connect ideas with each other by evaluating knowledge of the content (Chai et al., 2010; Mishra & Koehler, 2006, 2008). As for Pedagogical Knowledge (PK), it refers to the strategies, methods, or tactics teachers employ in teaching process where they should be responsible for planning, implementing, managing, and evaluating educational activities of students with an effort to specify and assess how students acquire skills and construct their knowledge through cognitive and social constructivism approaches in classroom environment (Mishra & Koehler, 2006, 2008).

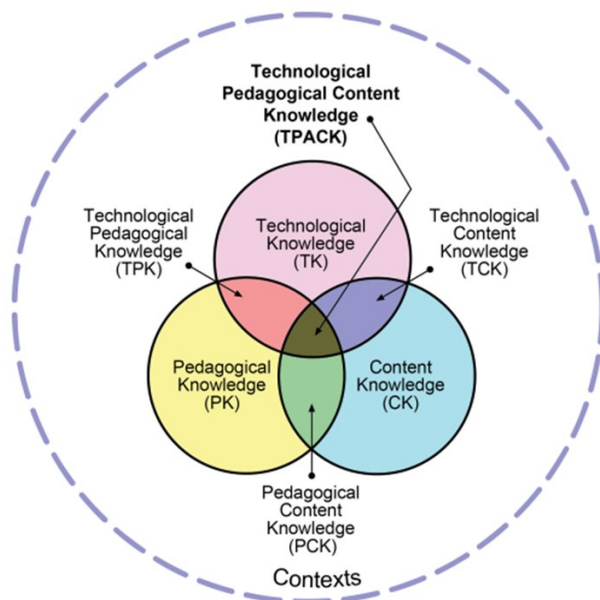


Figure 1. *Technological pedagogical content knowledge framework* (source: Koehler & Mishra, 2008)

Furthermore, there are four other domains emerged from the intersection of aforementioned three knowledge domains (Figure 1). These domains are named as Technological Pedagogical Knowledge (TPK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), and TPACK. The first coalescence is comprised of technological pedagogical knowledge (TPK) that involves the bond between technologies and pedagogical practices. The second one is pedagogical content knowledge (PCK), which is directly related to pedagogical practices and learning objectives. The third one is technological content knowledge (TCK) that expresses the relation between technologies and learning objectives. Being composed of the intersection of the aforementioned coalescence that displays a very complicated relation between the areas of knowledge, TPACK is generally defined as a dynamic conceptual framework teachers may use to design and deliver course content by employing technology to facilitate and enhance student learning process (Graham, 2011; Niess, 2011). It is also regarded as an instrument that assesses and reflects teachers' skills to combine

pedagogy, content and technology flexibly with their act of teaching (Harris et al., 2010; Schmidt et al.; 2009; Mishra & Koehler, 2006). In the field of education, TPACK has been the focal centre of researchers' interests. To illustrate, some researchers use TPACK as a self-assessment or self-reporting instrument to measure teachers' efficacy (Jen et al., 2016; Koh & Divaharan, 2013; Mouza et al., 2014; Schmidt et al., 2009; Tschannen-Moran & Hoy 2001). In addition, a body of research has made an attempt to both investigate artefacts designed by teachers (Harris et al., 2010; Koh et al., 2013) and explore teachers' performances through TPACK-based educational technology courses and activities (Graham et al., 2012; Jang & Tsai, 2012; Kafyulilo et al., 2015; Kramarski&Michalsky, 2010; Tokmak et al., 2013). In some studies, quite a few instruments are designed for the measurement of TPACK in specific areas such as science teachers (Canbazoglu-Bilici et al., 2013), geography teachers (Su et al., 2017), mathematics teachers (Bowers & Stephens, 2011), and language teachers (Baser et al., 2016; Chai et al., 2013).

In the field of EFL, the literature reveals that researchers are generally inclined to employ TPACK as a self-reporting instrument to assess perceptions, self-efficacy, competency, and skills of teachers. For example, in order to evaluate the effectiveness of intervention on TPACK in a qualitative study, Koçoğlu (2009) investigates how pre-service English teachers improve technology integration into their teaching practice. The study concludes that pre-service English teachers acquire high TPACK skills. In the same way, Kurt et al. (2014) examine Turkish pre-service English teachers' TPACK development in a 12-week intervention based on Learning Technology by Design approach (Mishra & Koehler, 2006) through the survey of Pre-service Teachers' Knowledge of Teaching and Technology (Schmidt et al., 2009). The results of the study report that there is a statistically significant increase in participants' TK, TCK, TPK and TPACK scores. In a mixed-method design Ersanlı (2016) questions the effectiveness of five-week training of pre-service English teachers. In the study, data are collected through TPACK Competency Survey (Archambault & Crippen, 2009) and journal entries of the participants. The results reveal that there is a statistically significant improvement in participants' TPACK scores. Oz (2015) explores pre-service English teachers' TPACK through a TPACK scale (Schmidt et al., 2009) with open-ended questions. The findings highlight that the participants develop their TPACK significantly. Similarly, Kwangsawad (2016) investigates pre-service English teachers' TPACK through a TPACK survey (Schmidt et al., 2009), lesson plans, and classroom observations in Thailand. The research shows that the participants have high scores in all domains of TPACK. Additionally, in a qualitative case study, Wetzel and Marshall (2011) explore in-service English teachers' performances on TPACK. The data for the research is collected through classroom observations and interviews. The study concludes that the teacher can display classroom management practices well. Wu and Wang (2015) examine TPACK of in-service English teachers through self-reported questionnaire, interviews and classroom observations. The results indicate that EFL teachers are confident in their PK and they need more technological knowledge to further develop their TPACK level. In a mixed-method study, Liu and Kleinsasser (2015) question in-service English teachers' TPACK and perceived computer self-efficacy in CALL training courses. In the study, a survey, interviews, and posted messages are used as data collection instruments. Data analysis shows an increase in in-service English teachers' TPK, TCK, TPACK ratings and computer self-efficacy scores. Rubadeau (2016) analyses cognitions and practices on the integration of pedagogy and technology of in-service English teachers. Data collection process is carried out through semi-structure interviews, classroom observations, written reflections, field notes, and documents reviews. The findings of the study emphasise that the participants show high levels of TPACK. Also, in a longitudinal study questioning whether pre-service teachers' perceived increase in TPACK skills follows a linear increase in four-year-long language education program, data for the study is collected through a TPACK survey with open-ended questions. The results of the study

underline that there is a nonlinear pattern of TPACK development in four-year-long education process (Turgut, 2017a).

Literature review reveals that a number of researchers have made an attempt to measure perceptions, self-efficacy, competency, and skills of pre-service and in-service English teachers through various data collection instruments including self-reporting surveys/questionnaires, open-ended questionnaires, interviews, and observations based on the framework of Teachers' Knowledge of Teaching and Technology (TKTT), which is frequently employed as the key instrument designed by Mishra and a group of researchers (Schmidt et al., 2009; Young et al., 2013)

Apart from its contribution to serving as an instrument to measure knowledge of English teachers, TPACK can also play an important role in revealing required competencies/skills to develop curricula in line with TPACK dimensions for pre-service English teachers and design professional development trainings for in-service English teachers in the 21st century. Using reliable and valid TPACK instruments as a lens for evaluating English teachers' knowledge may also have effect on quality of language teaching and design of professional development. Hence, in order to provide more accurate insights into the way how to better equip pre-service and in-service English teachers with required competencies/skills based on TPACK in the 21st century, it is essential to investigate how researchers in the field of EFL address the issues of reliability and validity of TPACK instruments in their studies. In addition to this, since there is the paucity of studies questioning how researchers in the field of EFL address the reliability and validity of TPACK instruments, to fill the gap in this field, the researcher intends to seek the evidence of reliability and validity of instruments reported in each of the reviewed studies through the following research questions:

- (1) What instruments are employed to measure TPACK in the reviewed studies?
- (2) Are the instruments reliable and valid to measure TPACK in the reviewed studies?

2. METHOD

2.1. Search Strategies and Procedure

To seek answers for the research questions, the search was performed on ERIC, ScienceDirect, Scopus, EBSCOhost, and Web of Science databases. Each search was repeated on the databases to check possible selection bias and then a comparison of the obtained studies was made. Afterwards, studies were identified where (a) TPACK was discussed in terms of pre-and in-service English teachers through titles, keywords, or abstracts. In order to obtain comprehensive search results, the keywords for each search were “technological pedagogical content knowledge”, “TPCK” “technological pedagogical and content knowledge”, and “TPACK” The search was limited to studies published between 2010 and 2019 in order to cover as many studies as possible.

2.1.1. Inclusion Criteria

A set of inclusion and exclusion criteria was employed in the process of publication selection (Table 1). Articles, full-text conference papers, and dissertations written in English were included. Other types of studies such as editorials, theoretical studies/reviews, book chapters, and other studies irrelevant to the focus of this review were excluded. The initial search yielded 235 studies. Firstly, the abstracts of the 235 studies were read and reviewed by the researcher. In case of any ambiguity, the study was completely read. After the inclusion and exclusion criteria were applied to yielded studies in line with the research questions, a quite few theoretical studies/reviews were excluded since they were irrelevant to the focus of this study. In addition to this, studies discussing TPACK from different perspectives were left out. As a result of the initial review of 235 studies, 75 studies remained for the researcher to complete

reading of them in-depth. In the event of borderline, an external researcher with insight into this field was also consulted to read the study. From the full-text reading, 60 studies (including 40 articles, 14 dissertations and 6 conference papers) were chosen for thorough analysis.

Table 1. *Inclusion and exclusion criteria*

Inclusion	Exclusion
Articles	Studies available in summary
Full-text conference papers	Editorials and summary reports
Dissertations	Book chapters
Studies in EFL with TPACK instruments	Theoretical studies / reviews

2.1.2. Data Coding Scheme

A total of 60 studies were applied to content analysis. The overall characteristics of the publications are classified according to a set of criteria including publication year, types of publication, instrument types, research design, reliability, validity, and target audience. At the study level, publication year, types of study, instrument types, and types of research design in each study were listed (Table 2 & 3). At the instrument-level analysis, target audience, reliability, and validity of each TPACK instrument were checked and testing process of each instrument's reliability and the validity was then reported.

Coding process was carried out by the researcher. When there was an ambiguous case, an external researcher with insight into content analysis and coding was consulted. A total of 60 studies were included for coding process. To establish the robustness of the coding, randomly selected 15 studies were coded independently by an external researcher. As a result of separate coding process, a high agreement (inter-coder reliability .89) was reached by the researchers. As the majority of the studies employed more than one type of TPACK instrument, each study in the review process was coded multiple times. For instance, in the research conducted by Abera (2014), interviews, classroom observations, documents, and a questionnaire were employed to reveal TPACK level of English teachers at tertiary level. For this reason, the study was coded four times since there were four different instruments in the same study.

3. FINDINGS

3.1. Study-level analysis

Most of the reviewed studies are articles and full-text conference papers (46 out of 60 studies). The remainder of the studies (14) consists of unpublished doctoral and master dissertations. The number of the studies into the use of TPACK in the field of ELT increases each year (Table 2). As for the kinds of TPACK instruments, more than two different types of TPACK instruments are identified in nearly half of the studies (a total of 128 out of 60).

Classification of studies in terms of research designs in the reviewed studies shows that half of the articles (20), all the conference papers (6), and half of the dissertations (7) are conducted by quantitative research designs in the reviewed studies. In seventeen of the articles and five of the dissertations, the researchers carry out their research based on qualitative research designs. For the remainder of articles (3) and dissertations (2), the researchers report mixed methods research design in their studies. Considering the types of studies in terms of research design, it is revealed that the researchers generally prefer to design their research based on quantitative and qualitative research designs rather than mixed method research designs.

To find out how each researcher addresses reliability and validity issues of each TPACK instrument and provides evidence of reliability and validity in their studies, a two-level analysis is conducted. First level analysis is based on revealing general characteristics (including types of study, publication years, types of TPACK instruments, and types of research design) of each

study in order to have a complete understanding about their studies (Table 2 & 3). At the instrument-level analysis, together with the target audience each TPACK instrument is examined in terms of reliability and validity (Table 4).

Table 2. Characteristics of the (N=60) studies in the review.

Category	Number	%
Study type		
Article	40	67%
Conference paper	6	10%
Dissertation	14	23%
Publication Year		
2011	1	2%
2012	2	4%
2013	5	8%
2014	9	15%
2015	11	18%
2016	8	13%
2017	11	18%
2018	7	12%
2019	6	10%
Instruments		
1	15	25%
2	18	30%
3	19	32%
4	5	8%
5	3	5%

Table 3. Classification of studies in terms of research designs in the review

Study type	Quantitative	Qualitative	Mixed method
Articles	N=20	N=17	N=3
Conference papers	N=6	N=0	N=0
Dissertations	N=7	N=5	N=2

3.2. Instrument-Level Analysis

Following study-level analysis, each TPACK instrument is counted in the reviewed studies. It is seen that there are five types of instruments that are not evenly distributed in the reviewed studies. Self-report instruments (60), interviews (32), and observations (21) are reported to be most used ones, whereas open-ended questionnaires (9) are identified to be the least preferred TPACK instruments in the reviewed studies (Table 4).

Table 4. *The description of instruments in terms of target audience, reliability, and validity*

Instruments	Self-report	Open-ended	Performance	Interview	Observation
Number of instruments	N=60, 46%	N=9, 7%	N=14, 11% 20%	N=25,	N=20, 16%
Target audience					
Pre-service	N=22, 37%	N=4, 44%	N=5, 36%	N=6, 24%	N=5, 25%
In-service	N=34, 57%	N=4, 44%	N=9, 64%	N=18,	N=12, 60%
Pre & in service	N=4, 6%	N=1, 12%	72% N=0, 0%	N=1, 4%	N=3, 15%
Reliability					
Clearly presented	N=40, 67%	N=4, 44%	N=3, 21%	N=2, 8%	N=2, 10%
Not presented	N=20, 33%	N=5, 56%	N=11, 79% 92%	N=23,	N=18, 90%
Validity					
Clearly presented	N=24, 40%	N=0, 0%	N=0, 0%	N=0, 0%	N=0, 0%
Not presented	N=36, 60%	N=0, 0%	N=0, 0%	N=0, 0%	N=0, 0%

3.2.1. Self-Report Instruments

Self-report instruments like Thurstone scales or Likert scales are regarded as the instruments in which participants are required to report directly on their own behaviours, beliefs, attitudes, or intentions (Lavrakas, 2008). As well, as the source of obtaining quantitative research data, self-report instruments like surveys or questionnaires should be proven to be valid, reliable, and unambiguous in the process of designing (Richards & Schmidt, 2002).

Nearly half of the instruments (60) are self-reported instruments that are used to assess TPACK of English teachers. More than half of the self-report instruments aim to measure TPACK of in-service English teachers. The four of the self-reported instruments are employed for the purpose of assessing both pre-and in-service English teachers (Drajati et al., 2018; Tseng et al., 2019; Turgut, 2017b; Wang, 2016). Most of the self-report instruments cover multiple sub-scales of TPACK framework. To illustrate, Vereshchahina et al. (2018) employ TPACK survey to analyse self-assessment of English instructors. The self-report TPACK instrument is composed of 39 items and 7 sub-scales based on TPACK framework. The study questions whether English teachers can successfully combine the content of English language and language teaching methods with sufficient use of computer technologies in order to achieve educational goals.

Forty of the studies provide the index of reliability based on cronbach's alpha. For example, Kharade and Peese (2014) express the reliability of the seven domains ranging from .83 to .93. As for validity, in less than half of the self-report instruments (24 out of 60) validity is established mostly through either exploratory or confirmatory factor analysis. For instance, in order to test of validity of TPACK-EFL, which is regarded as an assessment tool for teachers of English as foreign language (EFL), firstly survey items are constructed through mixed methods research design. The process of content validity of the items is conducted through expert and pre-service teacher reviews and then to validate the survey two rounds of exploratory factor analysis are carried out. The first-round analysis shows that the survey is composed of five-factor structure: technological knowledge (TK), content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK). There is also the fifth factor combining TCK, TPK, and TPACK items. Upon making revisions on the survey, the second round of analysis shows that there is a seven-factor structure consistent with the framework of

TPACK. The TPACK-EFL survey includes 39 items in total. Under the dimension of TK, CK, PK, PCK, TCK, TPK, and TPACK, there are 9, 5, 6, 5, 3, and 4 items respectively (Baser et al., 2016).

3.2.2. Open-Ended Questionnaires

Open-ended questionnaires refer to a set of questions whose responses/answers are constructed by interviewees (Lewis-Beck et al., 2004). Such questions can lead to a greater level of valuable discovery of information from the perspectives of respondents in qualitative research designs; however, since their open-ended nature makes it difficult to reflect what respondents mean to say, the issue of reliability and validity is of vital importance to researchers in order to yield as accurate and reliable data as possible (Nunan, 1999).

In the reviewed studies, only nine (out of 128) open-ended questionnaires are identified. In addition to this, only one of the open-ended questionnaires targets pre-service and in-service English teachers (Turgut, 2017b). In her study, the open-ended questionnaire is employed to investigate the participants' perceptions of how TPACK is modelled by English teachers. The aim of the open-ended questionnaire with three questions is to examine whether English teachers effectively display the integration of content, technology with teaching methods in the classroom. In the light of the responses of the participants, codes and themes are created by the researcher. Only four out of nine open-ended questionnaire instruments express inter-rater reliability as evidence of reliability. However, the issue of validity is not explicitly addressed in any of the open-ended questionnaire (Table 4).

3.2.3. Performance Assessments

Performance assessment describes an approach which requires participants to construct or perform an original response in accord with given authentic tasks or realistic scenarios (Frey, 2013; Good, 2008). Only 18 out of 128 instruments in the reviewed studies are identified as performance assessments. All of the instruments of performance assessments are designed to evaluate either pre-service or in-service English teachers. In some of TPACK performance assessment tasks, English teachers are asked to prepare a set of artefacts like teaching syllabi, instructional materials and reflective journals aiming to investigate the effectiveness and quality of English teachers' implementation of their teaching in line with the framework of TPACK (Alhababi, 2017), whereas in other TPACK performance assessment tasks English teachers are required to create a set of teaching artefacts such as web portfolios and digital stories to evaluate the effectiveness of TPACK framework (Harriman, 2011) and teachers' digital literacies (Weerakanto, 2019). In the reviewed studies, only three instruments of performance assessment present evidence of reliability through the inter-rater reliability (Chewning, 2015; Ersanli, 2016; Le & Song, 2018). None of the instruments of performance assessment provide any evidence of validity.

3.2.4. Interviews

An interview is a situation where the interviewer asks the interviewee a set of questions that are generally done face-to-face or over the telephone or recorded in audiotapes or videotapes for transcription. In addition, interviews are sometimes possible to be electronically conducted, such as over the Internet (Johnson et al., 2014; Johnson & Christensen, 2019; Gall et al., 2007). Considered to be one of the most frequently used instruments for qualitative data collection, an interview is a valuable method for questioning people's views and their meanings in a natural setting (Cohen et al., 2007). As Dörnyei (2007) avers, validity and reliability issues of these instruments serve as guarantees of research results and accuracy of data.

In total, 14 interview instruments (out of 25) do not provide any explicit and detailed information. Nine of the interviews are conducted in a semi-structured way. Only two interview

types (out of 25) are performed through a focus group interview where a group moderator guides a talk with a group of people such as students, or teachers to make them discuss the topic. The moderator also forms group talks with the help of open-ended questions by acting as a facilitator of the group (Johnson et al., 2014; Johnson & Christensen, 2019; Gall et al., 2007). For example, Asik et al. (2018) aim to get a detailed understanding of pre-service English teachers' use of digital tools, and each of the researchers conducts three focus group interviews with a total of 30 randomly selected participants. In focus group interviews, the participants are asked six questions prepared by the researchers in advance. With the permission of the participants, the researchers make the record of the interviews and then the record is prepared for analysis. In the reviewed studies, only one researcher (Alahmari, 2013), who questions English teachers' use of technology, their willingness to use technology, and their perceptions of TPACK, conducts the interviews electronically over Skype with 10 participants about 20 minutes on average. As for reliability of the instruments, only two of the studies out of 25 reports concrete evidence of reliability based on inter-rater reliability. In both of the studies, the percent agreement for two coders is .77 (Ansyari, 2012, 2015). Additionally, none of the studies provide an explicit evidence of validity (Table 4).

3.2.5. Observations

An observation means watching relevant phenomena by taking extensive field notes in both qualitative and quantitative research paradigms. Researchers record what is believed to be important in their field notes. In observational activities in the field, videotaping or audiotaping could also be employed to record necessary parts of observations (Johnson et al., 2014; Johnson & Christensen, 2019; Gall et al., 2007). While using less structured observation instruments in qualitative research designs, accuracy and consistency of observational data might be a threat to researchers who attempt to ensure good reliability and validity for their research results.

In the reviewed studies, only two out of 20 studies report the use of video recording (Kharade & Peese, 2014; Weerakanto, 2019). In one of those studies, the researcher intends to identify the perceptions of pre-service English teachers and the researcher also examines how the teachers apply technology to their pedagogical practices. Hence, the researcher conducts two class observations by video recording the teachers in three English language classrooms during nine weeks as a non-participant observer (Weerakanto, 2019). The video record is then transcribed to be examined and coded by the researcher. In 18 studies out of 20, the researchers take field notes during their observations in order to shed crucial light on how English teachers apply their knowledge of pedagogy, content, and technology in their classroom settings.

For instance, in the study of Tai (2015) in order to both understand how English teachers integrate technology into classroom teaching and identify how classroom activities are appropriately integrated with pedagogical approaches, the researcher employs an observation instrument including three sections: (1) Background Part, which gives a brief information regarding the role of the observer in the context and content (2) Competency Part including TPACK items for directing observations, and (3) Post Observation Part, which is for taking notes and writing down questions during observations. A total of 26 classes of thirteen English teachers are observed and then observation field notes are sorted into units of analysis to be examined and coded by the researcher. In the reviewed studies, only two of the studies using observation instruments perform the reliability of the instruments (Chewning, 2015; Tai, 2015) through the index of inter-rater reliability and report inter-coder reliabilities as .81 and .78 respectively. For validity, none of the studies provide any explicit evidence of validity (Table 4).

4. DISCUSSION and CONCLUSION

It is revealed that out of 128 instruments in 51 instruments, the reliability of those instruments is ensured through Cronbach's alpha and inter-rater reliability. Besides, the validity of the instruments is performed through expert content validity and factor analyses. Given that the number of studies based on quantitative research design in the reviewed studies, it is unsurprising to find out that the distribution of self-report instruments is nearly half of (46%) the total instruments. In a quantitative research design, survey research employs some sort of surveys or questionnaires to describe attitudes, opinions, perceptions or experiences (Creswell, 2005; Mertens, 2005). The majority of the reviewed studies underlines that the researchers utilise self-report instruments designed based on TPACK framework to investigate pre- and in-service English teachers' perceptions, beliefs, and self-efficacy. As Mertens (2005) explains, self-report instruments are used as the descriptive surveys to describe the characteristics of a group at one point in time.

The crucial point concerning the collected data through self-report instruments is that a self-report instrument by its very nature makes researchers trust what participants believe is true or what they have experienced. In view of Leedy and Ormrod (2013), researchers need to remember two important issues – reliability and validity when it comes to collecting self-reported data. Similarly, Winter (2000) also states that reliability and validity are tools of an essentially positivist epistemology. Thus, it might be more appropriate for researchers to select positivist research for their research since positivism, to some extent, is defined by a systematic theory of validity (Joppe, 2000), through which researchers truly measure what they intend to measure and ensure truthful outcomes regarding TPACK level of English teachers. Whereas reliability and validity are the terms of positivist quantitative paradigm that refer to the replicability and accuracy of measures, credibility and trustworthiness are the constructs of qualitative paradigm (Merriam & Tisdell, 2015; Saldana, 2011). That is to say, qualitative research is based on assumptions of a researcher about reality different from those of quantitative research. Taken the novelty of TPACK in the field of EFL and intricate nature of TPACK framework into consideration, it would not be a viable solution for researchers to employ solely qualitative paradigms in their research.

The employment of interview as an instrument to gather research data is in the second place, which shows that its use is slightly higher than that of observation instrument (Table 4). In the reviewed studies, interview data is collected through focus-group interviews and semi-structured interviews. Considering the challenges of data analysis of interviews, it is not surprising to find out that a very limited number of studies report reliability and none of those studies ensure the validity. Albeit interview's elusive nature as an instrument (Creswell, 2009), in order to increase its reliability and validity in qualitative studies, a try-out of the interview protocol, which is also known as a trial run is expected to be conducted by researchers prior to a full-scale study (Teijlingen van & Hundley, 2001). In every research design, instruments chosen for data collection are supposed to pass the tests of validity and reliability before they can be considered to be good measures, hence the conduct of a pilot study as fundamental to any research needs to be crucial for researchers in the field of English language teaching. A pilot interviewing may enable researchers to identify ambiguities with unnecessary questions, specify if each question elicits a sufficient response (Teijlingen van & Hundley, 2001), and most importantly allow researchers to practise and perfect interviewing techniques prior to real research settings (Berg, 2001).

As for observation as a data collection instrument in the reviewed studies, both quantitative and qualitative observations are employed by the researchers; however, only two of the studies report the reliability of observation instruments with no proof of validity provided by the researchers. The researchers conducting quantitative observation employ checklists and

videotape recorders to record data for coding later. As well, some of the researchers in the reviewed studies utilise a naturalistic observation in classroom settings where they take on the role of observer much more than a participant (Johnson & Christensen, 2019). Good reliability in an observation protocol depends on the consistency of observations across time and observers. Likewise, good validity in an observation protocol ensures that observation instrument measures what it is intended to measure (Maxwell, 2012). In other words, the reliability of an observed behaviour is also closely linked to the validity of the observation. Gardner (2000) asserts that reliability of an instrument imposes limits on its validity. To put it another way, lack of a valid protocol for observation especially in qualitative research design makes the reliability of the instrument ineffective (DeMonbrun et al., 2015).

Open-ended questionnaires are the least employed instrument in the reviewed studies. An instrument of open-ended questionnaire can prompt a lengthy and detailed response, much of which could not be relevant to the topic and might be hard to code for a researcher (Lewis-Beck et al., 2004). Similarly, in view of Koehler et al. (2012) the difficulties of coding and analysing data of open-ended questionnaire instruments could be among the important reasons why it is the least preferred instrument by the researchers.

The second least preferred instrument is performance assessment instruments. Performance assessment includes teaching syllabi, instructional materials, and reflective journals that are employed to identify how much the participants could put TPACK into practice in their acts of teaching. In particular the use of reflective journals in teacher education enables the researcher to make strong relationship with the participants (O'Connell & Dymont, 2011) by providing the researcher with an opportunity to hear the voice of them through their reflections while gaining practical TPACK experiences (Dunlap, 2006). As a means of data collection instrument in qualitative research designs, a reflective journal may also enable the researcher to evaluate the contributions of TPACK-related training or practices to English teachers. To the best of my knowledge, the challenge for the researcher lies in the difficulty of analysing and coding qualitative data gathered through reflective journals.

Considering the numbers of data collection instruments in the reviewed studies, qualitative data collection instruments in total are more than quantitative data collection instruments; however, self-report instruments provide higher ratio of reliability and validity when compared with that of all qualitative data collection instruments in the study. These issues in quantitative research design are dependent upon the construction of an instrument; however, in qualitative research design, the researcher is the instrument (Patton, 2001). Moreover, in qualitative research design what is largely missing in the literature for researchers is certainty about whether they are supposed to make an agreement based on codes, themes, or both codes and themes (Creswell & Poth, 2016). This may also account for less employment of qualitative research instruments than self-report instruments in the reviewed studies.

Given TPACK framework, it provides a theoretical background for teacher education that aims to integrate good teaching with technology by integrating technological, pedagogical, and content knowledge (Koehler & Mishra, 2005). However, not being thoroughly cognisant of what TPACK framework offers owing to its complex and overlapping structure, most of the researchers use TPACK as self-report instrument in their research to measure participants' perceptions, self-efficacy, competencies, and skills. Researchers in the field of English language teaching are expected to design and develop quantitative or qualitative data collection instruments that help measure how much English teachers truly demonstrate teaching activities, performances, and professional learning.

Another point that could be raised why the researchers employ mostly self-report instruments instead of other instruments is that TPACK is a complicated framework and covers multiple domains. According to Koehler et al. (2012), as TPACK is composed of multiple domains and

intersections, it requires sophisticated understanding of the domains and intersections for researchers to customise TPACK to a specific field of research and devise any kind of instrument. In the same vein, a group of scholars (Chai et al., 2010; Cox & Graham, 2009) find it difficult to pinpoint the distinction of each of the domains (PCK, TCK, and TPK) as the boundaries between them are quite fuzzy. Hence, complexities of distinguishing between those domains might make the development of a valid and reliable instrument also difficult for researchers in this field. In addition, another issue concerning why reliability and validity of the instruments occur in the reviewed studies is that the use of TPACK in this field has just started to emerge (Le & Song, 2018; Öz, 2015). This might be another explanation for inadequate number of instruments with the evidence of reliability and validity.

As an alternative to ensuring reliability and validity of instruments, triangulation seems to be a solution; however, according to Seawright (2016), triangulation in social sciences has considerable flaws. In the current study, for example in order to measure TPACK of English teachers the researchers collect data based on qualitative and quantitative research designs through different instruments including different questions even though they concentrate on the same TPACK framework. The use of instruments with different questions makes both the reliability and validity of the instruments and research findings problematic since the employment of quantitative and qualitative instruments including different questions may generate different findings. In his view (Seawright, 2016), the focal point of integrative multi-method research is to utilise each research method for what it is especially good at and to minimise inferential weaknesses by using other methods to test, revise, or justify assumptions. Thus, integrative designs employing multiple modes of inference to substitute strengths for weaknesses could be another solution especially for researchers who may have difficulty in ensuring reliability and validity of instruments in this field.

To sum up, though self-report instruments are highly versatile and relatively easy to employ, one of the weaknesses of self-report instruments is that participants may have an inclination to express themselves more differently than they really are (Bordens & Abbott, 2011). In qualitative studies the researchers are required to follow rigorous data collection and challenging data analysis processes based on their assumptions that influence quality and the results of the research (Gibbs et al., 2007; Kitto et al., 2008). Therefore, it might be supposed by the researchers that utilising quantitative and qualitative data collection instruments together in their studies would naturally resolve the issues of reliability and validity of such instruments as interviews and open-ended questionnaires. The reasons why a limited number of instruments like interview and open-ended questionnaire ensure reliability and validity might be attributed to meticulous data collection and challenging data analysis processes in qualitative research design or the researchers' assumption of triangulation. Besides, the complexities of measuring performance and real-life scenario tasks might prompt the researchers to use other instruments instead of performance assessment instruments.

Finally, since TPACK is newly emergent scope of research for researchers in the field of EFL, some issues like ensuring reliability and validity of instruments in either quantitative or qualitative research designs could appear to be exhausting and challenging, thus researchers could welcome integrative multi-method research designs as a panacea for especially minimising reliability and validity issues of their instruments and producing more reliable and accurate research results.

Despite the fact that TPACK has come under widespread criticism from scholars and researchers in every field of research, it is an undeniable fact that TPACK has made substantial contributions to the field of education by presenting a framework to question teachers' knowledge of content, pedagogy, and technology. Also, to the best of my knowledge, TPACK

offers an opportunity for teachers to replace traditional teaching methods with technology integrated ones to be able to perform their professions more efficiently and more effectively.

5. RECOMMENDATIONS

Future researchers should develop new TPACK instruments capable of measuring actual learning, performance, and real-life scenario tasks apart from the ones used to measure perception, belief self-efficacy through TPACK instruments. In addition to the use of Cronbach's alpha, inter-rater reliability, expert content validity, and factor analysis to ensure the reliability and validity of instruments, future researchers should also try using other ways of ensuring and increasing reliability and validity of instruments while devising new TPACK instruments to measure TPACK of English teachers. Future researchers should meticulously look into the ways how multi-method research designs and mixed methods research designs could be employed to measure English teachers' TPACK in further studies. Further researchers should also question how data triangulation process in a TPACK-research works in terms of reliability and validity and might be applied to better measure pre-service and in-service English teachers' TPACK.

Limited to investigate reliability and validity issues, this review has made an attempt to discuss how the issues of reliability and validity of instruments are addressed by the researchers within a limited number of studies in the field of EFL.

Declaration of Conflicting Interests and Ethics

The authors declare no conflict of interest. This research study complies with research publishing ethics. The scientific and legal responsibility for manuscripts published in IJATE belongs to the author(s).

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