# Development of the *TTF TPACK Survey* Instrument

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**Abstract**

*One of the major outcomes from the national Teaching Teachers for the Future (TTF) Project in 2011 was the development and statistical validation of a survey instrument to measure the Technological Pedagogical Content Knowledge (TPACK) of pre-service teachers as a result of the TTF intervention implemented across all Australian Education Institutions (HEI) delivering pre-service teacher education programs. The TTF project was positioned within the context of the emerging implementation of National Professional Standards for Teachers (AITSL, 2011) and focused specifically on the national curriculum areas of Mathematics, Science, English and History. The TTF TPACK Survey instrument developed for the TTF Project was informed by earlier work on the measurement of TPACK and ICT integration in classrooms (Albion, Jamieson-Proctor & Finger, 2010; Jamieson-Proctor & Finger, 2009; Jamieson-Proctor, Watson, Finger, Grimbeek & Burnett, 2007). The development of the instrument was guided by the TTF Research and Evaluation Working Group and incorporated additional items to extend the earlier developed TPACK Confidence Survey (TCS), in order to meet the particular needs of the TTF project. The data collected were subject to a battery of complementary analysis procedures using both the pre (N=12881) and post (N=5809) data. Four scales were investigated and confirmed as reliable: (1) Confidence - teacher items; (2) Usefulness - teacher items; (3) Confidence - student items; and (4) Usefulness - student items. This paper describes the theoretical framework and psychometric properties of the TTF TPACK Survey developed and administered in 2011.*

## Introduction – The TTF Project and TPACK

This paper summarises the development and psychometric properties of the Technological Pedagogical Content Knowledge (TPACK) Survey instrument that was developed for use in the *Teaching Teachers for the Future (TTF) Project*. The instrument is referred to consistently throughout this paper as the *TTF TPACK Survey* instrument. Given that the TTF Project involved all Australian Higher Education Institutions (HEIs) which provide teacher pre-service programs, the development of the *TTF TPACK Survey* was an important undertaking and makes a significant contribution to the international literature relating to the measurement of TPACK.

The TPACK framework, as shown in Figure 1, and described by Mishra and Koehler (2006), provides researchers and educators with concepts and terms to *describe* the intersection and interplay of three core teacher domains of knowledge, namely knowledge of content, pedagogy and technology. It is suggested that this conceptual framework could also provide a basis for making *predictions* and *inferences* about the consequences of changes made to any one of the components. Most significantly, the TPACK framework offers researchers and educators a common language to *bridge the gap* between research and curriculum design and provides guidance on how to apply the ideas in education contexts, including teacher pre-service programs. The framework supports an argument against teacher education and professional development programs that simplistically foreground teacher technology knowledge in isolation from content and pedagogy (Mishra & Koehler, 2006).
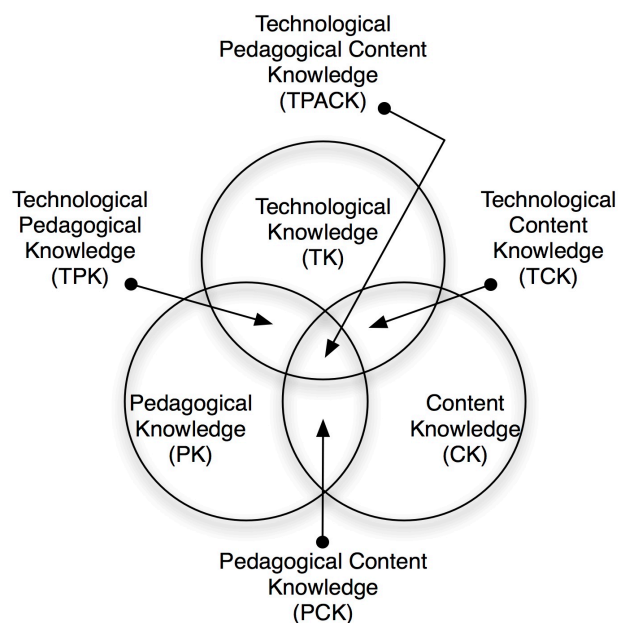


*Figure 1.* Technological Pedagogical Content Knowledge (TPACK)
[after Mishra and Koehler (2006)]

Mishra and Koehler's (2006) TPACK framework extends Shulman's (1986) seminal work on pedagogical content knowledge (PCK). Shulman (1987) claimed that, because researchers and teacher educators considered teachers' content knowledge (subject-specific knowledge) and pedagogical knowledge (how to teach) as mutually exclusive, teacher education programs either focused on content *or* pedagogy and graduates were therefore ill-prepared for the cognitive complexities of teaching. Shulman proposed PCK to describe the relationship between content and pedagogy. Mishra and Koehler (2006) argue that modern digital technologies (ICT) have changed the nature of the classroom sufficiently to justify extending Shulman's model to incorporate the intersections of technological knowledge (TK) with both content knowledge (CK) and pedagogical knowledge (PK), producing three more intersections (TPK, TCK, and TPCK) as represented in Figure 1. The acronym, initially TPCK, was later changed to TPACK for ease of pronunciation and to reflect the idea that the

three knowledge domains of technology, content and pedagogy form a "**T**otal **P**ACKage" (Thompson & Mishra, 2007, p. 38). Mishra & Koehler (2006) do not argue that the concepts represented by the TPACK framework are completely new, but what distinguishes their approach is their articulation of the *relationships* and interplay among the three core domains.

## Context of the Study – The TTF Project and TPACK Framework

The Digital Education Revolution (DER) initiated by the Australian Government from 2007 recognized that "educators require the pedagogical knowledge, confidence, skills, resources and support to creatively and effectively use online tools and systems to engage students" (AICTEC, 2009, p. 6). In 2010, the ICT Innovation Fund offered support for projects to improve the capabilities of pre-service and in-service teachers for working with ICT (DEEWR, 2010). The TTF Project (see http://www.ttf.edu.au) was conceptualised through the Australian Council of Deans of Education (ACDE) to involve all Australian higher education institutions (HEIs) which provide teacher pre-service education programs. The TTF project comprised three components, namely, extension of the graduate teacher standards to include ICT dimensions associated with the National Professional Standards for Teachers (AITSL, 2011), development of professional learning packages demonstrating ICT use in the first phase of the Australian Curriculum for English, Mathematics, Science and History, and the development of a National Support Network (NSN) to drive systemic change in pre-service teacher education in relation to the ICT dimensions.

The TPACK framework (Figure 1) was selected to underpin the TTF project because it represents the knowledge likely to be required of Australian teachers to achieve the intent of the DER (AICTEC, 2009). The design of TTF initiatives across Australia was guided by the TPACK framework and aimed to enhance the TPACK capabilities of participant pre-service teachers. A TTF Research and Evaluation Working Group (TTF REWG) was established comprising representatives from various participating institutions. The evaluation strategy comprised the development and administration of an efficient, reliable measurement instrument, as well as a 'most significant change' evaluation protocol. This paper focuses on the development of the *TTF TPACK Survey* instrument.

## TPACK Measurement

To inform the development of an instrument to measure TPACK, a search of the international literature was undertaken. This revealed that, while there has been an increasing interest in research related to TPACK, there is still variation in the understanding of TPACK and its component elements (Graham, 2011). The lack of commonality in the understanding of TPACK has contributed to the emergence of studies using instruments based on variations of the model. For example, early writing about TPACK described the changes in the TPACK capability of teachers in the context of graduate courses (Koehler & Mishra, 2005; Koehler, Mishra, & Yahya, 2007). Those studies were conducted with groups of only 17 (Koehler & Mishra, 2005) and 24 participants (Koehler, Mishra, & Yahya, 2007) and did not describe a methodology suitable for measuring changes in TPACK with large numbers of participants. Angeli and Valanides (2009) used a combination of peer, expert, and self-assessment to study what they called ICT-TPCK as a sub-set of the TPACK framework, and Lee and Tsai (2010) proposed TPCK-W as a variation in which the central technology was the World Wide Web. Even when the framework is used in its generic form, the review determined that specificity around the content being learned or the technology deployed presented complications for the development of instruments that are both general enough to be widely useful as well as specific enough to avoid vague generalisations.

Both self-report questionnaires and performance-based assessment of artefacts have been utilised for measuring TPACK development in pre-service-teachers. Performance-based assessment is time consuming and unsuitable for use with large groups or when a quick result is required and questionnaires face difficulties with framing questions to address the TPACK constructs and obtaining consistent interpretation by respondents (Graham, Cox, & Velasquez, 2009). In an endeavour to

overcome these difficulties, Albion, Jamieson-Proctor and Finger (2010) developed a self-report instrument to audit the TPACK of pre-service teachers. Their *TPACK Confidence Survey* (TCS) was based on an earlier instrument developed to measure ICT integration in the classroom (Jamieson-Proctor, Watson, Finger, Grimbeek, & Burnett, 2007), using a conceptual framework that described the productive ways school students used ICT across the curriculum. The items asked teachers how their *students* used ICT to achieve learning outcomes across the curriculum, thus probing the degree of CK, TK, PK and TPACK teachers used to facilitate the use of ICT by their students. That is, teachers were asked to rate their TPACK by rating the quantity and quality of their students' use of ICT. For example, item 2.8 in their instrument states, "In my class, students use ICT to develop deep understanding about a topic of interest relevant to the curriculum area(s) being studied." The researchers argued that it would be improbable for a teacher to have limited knowledge of pedagogy or curriculum content and have students use ICT to achieve 'deep' understanding in a curriculum area. These items, it was proposed, originally designed to measure ICT curriculum integration, could also be used to measure the newer construct of TPACK (Koehler & Mishra, 2008).

Further, Abbitt (2011) reported finding 33 studies that assessed TPACK, including 20 in pre-service teacher preparation programs and another study reported finding 141 instruments that measured some aspect of TPACK (Koehler, Shin, & Mishra, 2011). Despite this emerging range of studies aimed at measuring some element of TPACK, an examination of the surveys did not result in the identification of a widely accepted instrument able to be easily replicated for the purposes of the TTF Project evaluation.

This paper describes the conceptual design and psychometric properties of the *TTF TPACK Survey* instrument used to evaluate the change in pre-service teachers' TPACK as a result of their involvement in the TTF intervention conducted throughout 2011 at all participating Australian HEIs. The *TTF TPACK Survey* was administered pre and post the TTF intervention in each HEI to seek evidence of changes to the pre-service teachers' self-perceptions of their *confidence* to use ICT with a range of pedagogical strategies, and to support their future students' learning with ICT. Additionally, it aimed to measure the pre-service teachers' perceptions of *usefulness* of ICT for teaching and learning.

## Development and administration of the TTF TPACK Survey

The TTF project team determined that the TCS (Albion et al., 2010) represented a suitable core for development of a TPACK instrument for use in the project, based on its sound theoretical framework and psychometric properties. To restrict the final instrument to a practical length and because ICT use was the common thread across the different curriculum areas implemented during the TTF intervention, the survey instrument focused on the TPACK elements incorporating technology knowledge, namely TPK, TCK and TPACK. The 20-item scale of the original TCS which probed TPACK was extended with four items describing how pre-service teachers might support future school students' use of ICT in the curriculum. An additional set of 24 items was created to specifically explore pre-service teachers' TPK and TCK. These items asked the pre-service teachers to rate their use of ICT in their own teaching (in relation to content and pedagogy), rather than how their future students might use ICT. In both sets of 24 items the pre-service teachers were asked to rate both their perceived level of *confidence* with ICT, as well as their perceived level of *usefulness* of ICT to undertake the task described by each item. Figure 2 summarises the conceptual structure of the instrument.

| TPACK framework dimension | Scale: Confidence to use ICT to | Scale: Usefulness of ICT to |
|---|---|---|
| **TPACK** | 1. support student learning | 2. support student learning |
| **TPK, TCK** | 3. support teaching | 4. support teaching |

*Figure 2.* The conceptual structure of the *TTF TPACK Survey*

The survey provided seven response categories, coded 0 to 6, plus an additional, 'Unable to Judge' category. Three (of 6) response options were labeled:

- 0 – Not confident/useful
- 3 – Moderately confident/useful
- 6 – Extremely confident/useful

The instrument was implemented using Qualtrics™ online survey software and administered to all students in teacher preparation programs at all participating HEIs in May-July 2011 (N=12 881) and again in October-November 2011 (N=5809). The data were subjected to a suite of complementary data analysis techniques involving both parametric and Rasch analyses (see, for example, Bond & Fox, 2007) to establish the factor structure and measurement properties of the instrument.

## Parametric analysis methods and results

Parametric analysis was conducted with IBM SPSS v20 and AMOS 20.

Factor analyses (Principal Components Analysis with Varimax rotation) were performed on initial survey responses (pre-test) with the aim of identifying statistically credible and theoretically intelligible factors. Once the factor were identified, these were confirmed via Maximum Likelihood extraction with Oblimin rotation. Based on the confirmed factors, factor scores were computed for the extracted scales.

With respect to the 24 items hypothesised to measure TPK and TCK, two sets of exploratory factor analyses were conducted. The first set of analyses examined outcomes based on the proposed confidence scale and the other examined the usefulness scale. In relation to both confidence and usefulness, the items produced two-factor solutions if not constrained. However, all confidence and usefulness items loaded on single factors at .4 or higher when constrained to do so (Stevens, 1992). As it was in keeping with the theorised "confidence" and "usefulness" scales, the single factor solution was accepted.

Table 1 provides the 24 TPK/TCK items, their factor loadings and reliability coefficients for the extracted factors of confidence and usefulness of the *TTF TPACK Survey*.

Table 1
*Items with Single Factor Varimax Loadings and Reliability Coefficients for the 24*
*TPK/TCK Items from the TTF TPACK Survey (Initial survey N = 12881)*

| TPK, TCK Items | Single-factor: Confidence | Single-factor: Usefulness |
|---|---|---|
| **How <u>confident</u> are you that you have the knowledge, skills and abilities to support students' use of ICT to…** | | |
| **How <u>useful</u> do you consider it will be for you, as a teacher, to ensure your students use ICT to…** | | |
| demonstrate knowledge of a range of ICT to engage students | 0.76 | 0.73 |
| use ICT and teaching strategies that are responsive to students' diverse backgrounds | 0.73 | 0.73 |
| use ICT and teaching strategies that are responsive to students' learning styles | 0.76 | 0.73 |
| use ICT and teaching strategies to support students from Aboriginal and Torres Strait Islander backgrounds | Excluded | Excluded |
| use ICT and teaching strategies to personalise learning activities for students | 0.78 | 0.76 |
| use ICT to access, record, manage, and analyse student assessment data | Excluded | 0.69 |
| use ICT to teach specific subject areas in creative ways | 0.74 | 0.75 |
| design learning sequences, lesson plans and assessments that incorporate ICT use by students | 0.70 | 0.72 |
| select and organise digital content and resources | 0.73 | 0.71 |

| | | |
|---|---|---|
| use ICT for reporting purposes, such as reporting to parents/carers | 0.83 | 0.81 |
| demonstrate how ICT can be used to support literacy learning | 0.83 | 0.81 |
| demonstrate how ICT can be used to support numeracy learning | 0.78 | 0.74 |
| design ICT activities that enable students to become active participants in their own learning | 0.85 | 0.83 |
| select and use a variety of digital media and formats to communicate information | 0.82 | 0.80 |
| engage parents and families in their child's schooling through ICT | 0.84 | 0.82 |
| manage challenging student behaviour by encouraging the responsible use of ICT | 0.84 | 0.83 |
| be aware of digital citizenship to promote student demonstration of rights and responsibilities in using digital resources and tools | 0.85 | 0.82 |
| identify personal and professional learning goals in relation to using ICT | 0.81 | 0.74 |
| reflect on relevant ICT research to inform professional practice | 0.77 | 0.74 |
| use a range of ICT resources and devices for professional purposes | 0.79 | Excluded |
| use ICT to engage with colleagues to improve professional practice | 0.78 | 0.75 |
| use ICT to collaborate for professional purposes, such as online professional communities | 0.84 | 0.80 |
| evaluate how ICT use has helped to achieve specific subject area goals | 0.82 | 0.78 |
| demonstrate an understanding of safe, legal and ethical use of digital information and technologies | 0.85 | 0.81 |
| **Cronbach's Reliability Coefficients** | **.97** | **.97** |

NB. 4 items were excluded from the final scales. See Table 3 below.

With respect to the 24 items proposed to measure TPACK, two sets of exploratory factor analyses were again conducted - one for confidence and one for usefulness. In relation to both confidence and usefulness, the items produced acceptable single factor solutions when un-constrained with all items loading on the single factor at .4 of higher (Stevens, 1992).

Table 2 provides the 24 TPACK items, their factor loadings and reliability coefficients for the extracted factors of confidence and usefulness of the *TTF TPACK Survey*.

Table 2
*Items with Single Factor Varimax Factor Loadings and Reliability Coefficients for the 24 TPACK Items from the TTF TPACK Survey ((Initial survey N = 12881)*

| TPK, TCK Items | Single-factor: Confidence | Single-factor: Usefulness |
|---|---|---|
| **How <u>confident</u> are you that you have the knowledge, skills and abilities to support students' use of ICT to…** | | |
| **How <u>useful</u> do you consider it will be for you, as a teacher, to ensure your students use ICT to…** | | |
| provide motivation for curriculum tasks | 0.85 | 0.83 |
| develop functional competencies in a specified curriculum area | 0.87 | 0.86 |
| actively construct knowledge that integrates curriculum areas | 0.88 | 0.87 |
| actively construct their own knowledge in collaboration with their peers and others | 0.89 | 0.86 |
| analyse their knowledge | 0.88 | 0.85 |
| synthesise their knowledge | 0.88 | 0.86 |
| demonstrate what they have learned | 0.87 | 0.84 |
| acquire the knowledge, skills, abilities and attitudes to deal with on-going technological change | 0.86 | 0.83 |
| integrate different media to create appropriate products | 0.85 | 0.84 |
| develop deep understanding about a topic of interest relevant to the curriculum area/s being studied | 0.88 | 0.87 |
| support elements of the learning process | 0.90 | 0.88 |
| develop understanding of the world | 0.86 | 0.83 |
| plan and/or manage curriculum projects | 0.88 | 0.86 |

| | | |
|---|---|---|
| engage in sustained involvement with curriculum activities | 0.90 | 0.88 |
| undertake formative and/or summative assessment | 0.86 | 0.84 |
| engage in independent learning through access to education at a time, place and pace of their own choosing | 0.86 | 0.82 |
| gain intercultural understanding | 0.83 | 0.81 |
| acquire awareness of the global implications of ICT-based technologies on society | 0.85 | 0.82 |
| communicate with others locally and globally | Excluded | Excluded |
| understand and participate in the changing knowledge economy | 0.83 | 0.81 |
| critically evaluate their own and society's values | 0.85 | 0.82 |
| facilitate the integration of curriculum areas to construct multidisciplinary knowledge | 0.88 | 0.86 |
| critically interpret and evaluate the worth of ICT-based content for specific subjects | 0.87 | 0.83 |
| gather information and communicate with a known audience | 0.84 | 0.83 |
| **Cronbach's Reliability Coefficients** | **.99** | **.98** |

NB. 2 items were excluded from the final scales. See Table 3 below.

Finally, while broadly speaking, analytic solutions included both two-factor and single-factor solutions for level of confidence and usefulness, it was decided that single factor solutions were preferable for both. Single factor solutions simplify the array of factor scores and use all rather than some of the items, but, most importantly, they align with the 4 initially theorised factors.

## Rasch analysis methods and results

The pre-test data (T1) (N=12881) were analysed to investigate, among other things, the extent to which the two 24-item groups (TCK/TPK and TPACK) could be combined together to construct meaningful subscales to produce measures of underlying pre-service teacher perceptions of ICT use for learning and teaching. Groups of like-named items (i.e., TPK/TCK Confidence; TPK/TCK Usefulness; TPACK Confidence; TPACK Usefulness) were analysed using the Rasch Rating Scale Model (Andrich,1978; Bond & Fox, 2007). Misfitting items, listed in Table 3, were removed until all remaining items showed adequate fit to the model's requirements for measurement. Dimensionality was confirmed by primary components factor analysis of the Rasch item/person residuals. Where the Category Characteristic Curves showed that the provided response options were not used as intended, adjacent response categories were combined as required to achieve satisfactory Category performance.

Table 3
*Table of Misfitting Items (Four Scales)*

| Item Code | Item |
|---|---|
| | **Scale TPK/TCK Confidence Combined** |
| Q18C_4 | Teach strategies to support students from Aboriginal and Torres Strait Islander backgrounds |
| Q18C_6 | Access, record, manage, and analyze student assessment data |
| | **Scale TPK/TCK Usefulness Combined** |
| Q18U_4 | Teach strategies to support students from Aboriginal and Torres Strait Islander backgrounds |
| Q20U_17 | Manage challenging student behaviour by encouraging the responsible use of ICT |
| | **Scale TPACK Confidence Combined** |
| Q23C_19 | Communicate with others locally and globally |
| | **Scale TPACK Usefulness Combined** |
| Q23U_19 | Communicate with others locally and globally |

Note: Each of items Q18C_6, Q23C_19 and Q23U_19 combine two or more meanings (using the conjunctive form, 'and'). Other misfitting items refer to behaviour management and teaching Aboriginal and Torres Strait Islander students.

The pre-test scales were replicated from the post-test (T2) data (N=5809) following identical steps. In order to display item changes from T1 to T2 for each of the four large scales the following analyses were conducted:

- Person centred (mean @ 0.0) Rasch analysis of the T1 data using the category estimates from T1 free analysis
- Person centred (mean @ 0.0) Rasch analysis of the T2 data using the same category estimates from T1 free analysis.

These analyses yielded estimates (and SEs) for each item in each subscale at both time-points.

The measurement properties of the four scales namely: TPK/TCK Confidence; TPK/TCK Usefulness; TPACK Confidence; TPACK Usefulness, were confirmed both at T1 and T2. This required the omission of a small number of items and the combining of response categories for three scales.

## General conclusions

The *TTF TPACK Survey* was constructed by the TTF REWG, based on previous research and instruments which professed to measure TPACK (Albion, Jamieson-Proctor & Finger, 2010), with consideration of the *National Professional Standards for Teachers* (AITSL, 2011), and the TTF Project focus curriculum areas of Science, History, English and Mathematics. The instrument was initially trialed by the TTF Project Coordinators and TTF Pedagogical Officers at each HEI prior to being used to measure the impact of the TTF intervention on all participating students at each institution, pre and post-intervention. The results of the TTF intervention as measured by the *TTF TPACK Survey* are reported separately. This paper reported the development of the 4 main scales that form the basis of the *TTF TPACK Survey* namely: the TPK/TCK Confidence & Usefulness scales and the TPACK Confidence and Usefulness scales. The psychometric and measurement properties of all four scales were investigated and confirmed at T1 and T2 using both parametric and Rasch analytical techniques. This required the omission of 6 items (see Tables 1 & 2) and the combining of response categories for three scales.

The instrument was based on a theorised 4-factor structure, comprising scales to measure pre-service teachers' perceptions of *confidence* with and *usefulness* of ICT in respect to their (1) Technological Content Knowledge (TCK) and Technological Pedagogical Knowledge (TPK), as well as (2) their Technological Pedagogical Content Knowledge (TPACK). The 4 factors of the *TTF TPACK Survey* were designed to measure the components of the TPACK framework (Mishra & Koehler, 2006) incorporating technology knowledge, specifically TPK, TCK and TPACK. This decision was made by the TTF REWG, as the focus of the TTF project was to enhance graduate teachers' capacity to situate ICT as integral to the curriculum in Australian schools. Hence, it was decided to focus on the components of the TPACK framework that foreground technology knowledge in combination with content and pedagogy.

In conclusion, the *TTF TPACK Survey*, is underpinned by a sound conceptual basis, informed by contemporary Australian and international literature relating to recent trends in the definition and measurement of ICT use in education contexts, as well as current theoretical frameworks with respect to the teacher knowledge bases required when using ICT in the curriculum. It has undergone an extensive evaluation process that has refined and confirmed the instrument's psychometric, measurement and conceptual structure. Therefore, the researchers contend that the *TTF TPACK Survey* is suitable for use in future longitudinal studies of TPACK in educational contexts. The instrument will accommodate new and emerging digital technologies, curriculum changes, and contribute to further TPACK research which focuses on 'measuring TPACK'. As with all self-report instruments, data collected with this instrument should be complemented with other data collection methodologies where practicable to overcome the limitations associated with self-report instruments.

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