TPACK Concepts and Practices
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ABSTRACT

TPACK (Technological Pedagogical Content Knowledge) is a theoretical concept that has seen widespread adoption in the area of teacher development for technology integration. This presentation analyses the theoretical development of the TPACK construct and examples of its application for teacher development in pre-service and in-service contexts. It will also discuss future directions for the research and application of TPACK.

AGE

1. Theoretical conceptions of TPACK
2. Application 1 – TPACK as teacher education framework
3. Application 2 – TPACK for teacher profiling
4. Application 3 – TPACK for lesson design
5. Synthesizing the approaches – An example
6. Future Directions

WHAT IS CONTENT KNOWLEDGE (TPACK)?

- Teachers’ body of knowledge in terms of technology integration
- A form of professional understanding
- Acronym changed from TPKC to TPACK to better reflect the integrations between Technology, Pedagogy, and Content Knowledge for effective technology integration (See Thompson & Mishra, 2007)
THE TPACK

CONSTRUCTS (MISHRA & KOEHLER, 2006) Why teaching teachers TK alone does not help them better integrate technology.
### BASIC ELEMENT

<table>
<thead>
<tr>
<th>TPACK Constructs</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>TK (Technological Knowledge) PK</td>
<td>Knowledge about how to use ICT hardware and software and associated peripherals</td>
<td>Knowledge about how to use Web 2.0 tools (e.g., Wiki, Blogs, Facebook)</td>
</tr>
<tr>
<td>TK (Pedagogical Knowledge)</td>
<td>Knowledge about the students’ learning, instructional strategies, different</td>
<td>Knowledge about how to use problem-based learning (PBL) in teaching different subject matter</td>
</tr>
<tr>
<td>TK (Content Knowledge)</td>
<td>educational theories, and assessment methods</td>
<td></td>
</tr>
<tr>
<td>TK (Science or Math subjects)</td>
<td>Knowledge of the subject</td>
<td></td>
</tr>
<tr>
<td>CK (Content Knowledge)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### INTEGRATION OF TWO

| PCK (Pedagogical Content Knowledge)                          | Knowledge of representing content knowledge and adopting pedagogical strategies to make the specific content/topic more understandable for the learners | Knowledge of using analogies to teach electricity (see Shulman, 1986)                                       |
| TPK (Technological Pedagogical Knowledge)                    | (Not subject specific)                                                                                     |                                                                                                             |
| TPK (Technological Content Knowledge)                        | Knowledge about how to use technology to represent/research and create the content in different ways       | Knowledge about online dictionary, corpus technology, Geospatial technology (Google earth and map), Geometer’s Sketchpad, specialized databases, data logger, topic specific simulation |
| TPK (Not considering teaching)                               |                                                                                                             |                                                                                                             |
SYNTHESIS ON THE TREE

<table>
<thead>
<tr>
<th>TPACK</th>
<th>Knowledge of using various technologies to teach, represent, and facilitate knowledge creation of specific subject content</th>
<th>Knowledge about how to use Wiki as a communication tool to enhance collaborative learning in social science</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Technological Pedagogical Content Knowledge)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


HOW DO TEACHERS
KOEHLER, MISHRA & YAHYA (2007)

Purpose: Trace the TPACK development of 18 graduate students as they designed an online course.

Data source: Transcript of classroom discussions, interviews, and observations.

Examples of coding adapted from the article:
☐ CK: Teaching examples e.g. spanking, not spanking
☐ PK: “They need to build teambuilding skills”
☐ TK: “Use dropdowns for links to the chapter”
☐ PCK: “How do you use rewards for learning?”
☐ TCK: “Make a link to some websites on jigsaw learning”
☐ TPK: “Where will students click to get to that activity?”
☐ TPACK: “How to deliver this content to students? Use powerpoint?”

Key conclusion: Integration of technology, pedagogy, and content occur through design.
Which Teacher Has

Teacher A

Teacher B

The ICT-TPCK

VALANIDES, 2009)

Knowledge of how to teach difficult content more effectively with ICT.

TPACK-IN-ACTION MODEL (CHAI, KOH & TSAI, 2013)
MULTILEVEL CONTEXTUAL TPACK (CHAI, KOH, LIM, & TSAI, 2014)
ST 21 CENTURY LEARNING DESIGN THINKING MODEL (KOH, CHAI, WONG & HONG, 2015)

Fig. 1 21CL ICT design thinking framework (21CL-ICTDT)
### TPACK As Teacher Application in Education Framework

#### Mapping Teacher Education (Niess, 2005)

![Diagram](image)

**Fig. 1.** Teacher preparation program displaying program themes (technology theme shaded).
The TTF Project-Australia (Source: [Http://TTFEDU.AU/](http://TTFEDU.AU/))

Designing Ict Pedagogies In Teacher Education (Koh & Divaharan, 2011)

![Diagram of TPACK Model](image)

**Figure 4. Revised TPACK-Developing Instructional Model.**

TPACK FOR TEACHER APLICATION 2

Proliferation Of

1. General TPACK survey (Schmidt et al., 2008; Chai, Koh, & Tsai, 2010)
2. TPACK for K-12 online instruction (Archambault & Crippen, 2009)
3. TPACK for Science survey (Graham et al., 2009)
4. Web-based TPACK (Lee & Tsai, 2010)
5. **TPACK for Meaningful Learning** (Chai, Koh, & Tsai, 2011; Koh, Chai, & Tsai, 2014)

### Analysis Of TPACK CLUSTERS (KOH & CHAI, 2014A)

<table>
<thead>
<tr>
<th>Cluster 1</th>
<th>Cluster 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-service (N = 104, 100.008)</td>
<td>Pre-service (N = 102, 100.000)</td>
</tr>
<tr>
<td>Cluster size</td>
<td>In-service (N = 102, 100.000)</td>
</tr>
<tr>
<td>Cluster 1</td>
<td>Cluster 2</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male (N = 50, 54.003)</td>
<td>Male (N = 67, 93.108)</td>
</tr>
<tr>
<td>Female (N = 42, 45.708)</td>
<td>Female (N = 67, 93.108)</td>
</tr>
<tr>
<td>Years in service</td>
<td></td>
</tr>
<tr>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>M = 24.47</td>
<td>M = 24.47</td>
</tr>
<tr>
<td>SD = 2.82</td>
<td>SD = 2.82</td>
</tr>
<tr>
<td>Pro-TK</td>
<td></td>
</tr>
<tr>
<td>M = 5.25</td>
<td>M = 5.25</td>
</tr>
<tr>
<td>SD = 1.5</td>
<td>SD = 1.5</td>
</tr>
<tr>
<td>Pre-PK</td>
<td></td>
</tr>
<tr>
<td>M = 5.56</td>
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</tr>
<tr>
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<td>SD = 1.5</td>
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</tr>
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<td>Pre-TPACK</td>
<td></td>
</tr>
<tr>
<td>M = 5.56</td>
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</tr>
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<td>SD = 1.5</td>
</tr>
</tbody>
</table>

IN-SERVICE TEACHERS’ PERCEIVED TPACK CONNECTIONS (KOH, CHAI, & TSAI, 2013)
Fig. 3 Unbroken paths to TPACK
INFLUENCE OF DESIGN DISPOSITIONS (KOH, CHAI, HONG & TSAI, 2015)

Table 3. Results of structural equation modelling.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Path</th>
<th>Path coefficient</th>
<th>Standard error</th>
<th>Critical ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DD → LDP</td>
<td>0.50***</td>
<td>0.08</td>
<td>7.09</td>
</tr>
<tr>
<td></td>
<td>DD → TPACK</td>
<td>0.17*</td>
<td>0.08</td>
<td>2.03</td>
</tr>
<tr>
<td>2</td>
<td>LDP → TPACK</td>
<td>0.69***</td>
<td>0.08</td>
<td>8.97</td>
</tr>
</tbody>
</table>

Note: *p < 0.05, ***p < 0.001.

Figure 1. The structural equation model of DD, LDP, and TPACK.
DESIGN OF PRE-SERVICE ICT MODULE AT NIE (CHAI, KOH & TSAI, 2010)

REDESIGN OF PRE-SERVICE ICT MODULE AT NIE (KOH & CHAI, 2012)

Comparison of 2
Pros and Cons of

a. Allows understanding of teachers' perceptions

b. Allows modelling of teacher development trends

Based on perception data

Does not tell you how teachers make design happen

Gaps in Teachers

Analysis of pre-service teachers ‘ICT

Lesson plans

Faced challenges in designing student-centered lesson activities to support knowledge construction
TPACK FOR LESSON DESIGN
Aplication 3

TPACK AS LESSON IDEAS

The “Interpreter” Activity Types

In the discipline of mathematics, individual concepts and relationships can be quite abstract, and at times can even represent a bit of a mystery to students. Often students need to spend some time deducing and explaining these relationships to internalize them. Educational technologies can be used to help students investigate concepts and relationships more actively, and assist them in interpreting what they observe. This table displays activity types that can support thoughtful interpretation processes, and provides some examples of the available technologies that can be used to support forming the interpretations.

<table>
<thead>
<tr>
<th>Activity Type</th>
<th>Brief Description</th>
<th>Possible Technologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pose a Conjecture</td>
<td>The student poses a conjecture, perhaps using dynamic software to display relationships</td>
<td>Dynamic geometry software (e.g., Geometer’s Sketchpad), Common-specific interactive tools (e.g., Explain Everything), email</td>
</tr>
<tr>
<td>Develop an Argument</td>
<td>The student develops a mathematical argument related to why they think something is true. Technology may help in form and to display that argument</td>
<td>Concept mapping software, presentation software, Microsoft, specialized word processing software (e.g., Theoreti)</td>
</tr>
<tr>
<td>Classify</td>
<td>The student attempts to examine a conjecture relationship in order to categorize it into a set of known categories</td>
<td>Database software, online databases, concept mapping software, drawing software</td>
</tr>
</tbody>
</table>

Source: http://activitytypes.vws.edu/  
JOYCE KOH (2016)
TPACK CONSTRUCTS AS EPISTEMIC RESOURCES (CHAI & KOH, 2017)

ICT lesson planning models are designed to trigger consideration of different TPACK aspects

Determining the lesson objectives

Choose Technology and Pedagogical Activities

Plan instructional activities

Choose Media/ Create ICT-based resource

Develop assessment tools: Formative & Summative

TPK What are some of the potential soft skills that can be learned through these pedagogical activities? (e.g. reflective, critical thinking, collaboration, learning, authentic problem solving, active knowledge creation etc.)

Outcome: Students can distinguish and learning activities supported by technology.

Outcome: More in-depth student learning and learning processes usually involves evaluating digital artifacts created by students using relevant.

TK What is the significance of these technologies in addressing the topic? How do subject matter experts use technology to represent, and make meaningful this topic?

TPACK resources are those existing online resources that have already been developed.
### TPACK AS DESIGN THINKING (KOH & CHAI, 2014)

<table>
<thead>
<tr>
<th>Transcript</th>
<th>TPACK Transformations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <strong>HOD</strong></td>
<td></td>
</tr>
<tr>
<td>a. Did we consolidate and collate their responses?</td>
<td>TPK (Clarify)</td>
</tr>
<tr>
<td>b. In our initial conception, we said that they could key in their responses into the portal so that they can revisit their own or their friends’ answers.</td>
<td>TPACK (Clarify)</td>
</tr>
<tr>
<td>c. Since they have so many responses, why don’t they key it somewhere?</td>
<td>TPACK (Propose New)</td>
</tr>
<tr>
<td>d. They can use their phone or the laptop.</td>
<td>TPACK (Clarify)</td>
</tr>
<tr>
<td>2. <strong>Teacher A - There were two questions on the LMS forum for them to write their points about the flags.</strong></td>
<td></td>
</tr>
<tr>
<td>3. <strong>HOD</strong></td>
<td></td>
</tr>
<tr>
<td>a. How about archiving their own responses?</td>
<td>TPACK (Clarify)</td>
</tr>
<tr>
<td>b. How about a Google Doc for each group?</td>
<td>TPACK (Refine new idea)</td>
</tr>
<tr>
<td>c. It will be good to record their own learning, consolidate and share with their friends.</td>
<td>TPACK (Support new idea)</td>
</tr>
<tr>
<td>4. <strong>Teacher B - The problem with the phone is that students cannot access shared resources, even using Google Docs on</strong></td>
<td>TPK (Identify Gap)</td>
</tr>
</tbody>
</table>


![Table 1](image)
Synthesizing The Approaches
A 1 Year Design-Based Tpack Development Process For School-Based Ictintegration
(Koh, Chai & Lim, In-Press)

Participants
1. 2 Singapore primary schools
2. 47 teachers, organized into 10 subject-based design teams
3. Schools are focusing on integrating 21st century learning into curriculum

EXAMPLE OF REDESIGNED LESSON – MATH

**Initial design**

Use online manipulatives for PS students to practice visualization of fractional parts.

Create a totally new lesson for the topic of Averages that is based on authentic problem-solving.

**Final design**

Problem 1 – Distribute a bag of sweets equally among peers (whole numbers).

Problem 2 – Compute school’s average utility bill across the school year with Microsoft Excel™, analyse possible reasons for above-average usage in particular months & brainstorm ways for conservation.

Problem 3 – Collect data to find average mass of peers’ school bags and individually reflect on strategies to avoid carrying unnecessarily heavy bags to school.
Example Of Redesigned Lesson –Science

**Initial design**
Teachers teach the characteristics of open and closed circuits, parallel and series circuits, and electrical conductors.

Students conduct experiments.

Students still weak in analysing problems related to circuits and articulating scientific explanations.

**Final design**
Lesson 1 – Use students’ postings on Padlet™ at beginning and end of lesson to assess students’ understanding of open and closed circuits.

Lesson 2 – Students explore computer-based simulation and build explanations of observations using POE (Predict, Observe, Explain).

Lesson 3 – Students diagnose actual circuits for problems, with the option of using simulations as scaffolds. Provide explanations using POE.

Lesson 4 – Students use different materials provided by teachers and themselves to set-up circuits and use POE to explain if those were conductors.

Example Of Redesigned Lesson –English

**Initial design**
P5 students produced draft of essay by writing collaboratively with online platform Titanpad™.

Students consolidated ideas face-to-face to produce a final project.

Implementation results – Students unable to judge how they could expand the content of their writing.

**Final design**
Self-paced learning of techniques for “ballooning” sentences with self-paced learning packages on Powerpoint™.

Practice “ballooning” sentences and paragraphs using Titanpad™.

Online editing & peer commenting with Titanpad.

Outcomes
TPACK Survey - Improved teacher confidence in TPACK
1. TPACK lesson design – 9 out of 10 groups improved their lesson design ratings for meaningful learning dimensions
2. Evidence of improvement in student learning

FUTURE DIRECTIONS
For Pre-Service Teacher Education
1. Assess both teacher perceptions and design products
2. Develop TPACK Activity Types as scaffolds for specific technologies, pedagogies, and content
3. Develop lesson planning scaffold

FOR IN-SERVICE TEACHERS
1. Engage TPACK development in school-based design teams
2. Examine teachers’ design outcomes and impact on student learning
3. Examine teachers’ design thinking for supporting TPACK development

REFERENCES


