# UNPACKING PERFORMANCE INDICATORS IN THE TPACK (TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE) LEVELS RUBRIC TO EXAMINE DIFFERENCES IN THE TPACK LEVELS FOR TEACHING MATHEMATICS IN PRIMARY SCHOOLS


## Aleksandra Kaplon-Schilis*, Irina Lyublinskaya**

## *Durham Academy, NC, USA; **Teachers College, Columbia University, NY, USA



*Aleksandra.Kaplon-schilis@da.org
**il2369@tc.columbia.edu


## Rationale

The TPACK Levels rubric (Lyublinskaya & Tournaki, 2012) has been used in various studies to assess teacher growth for technology integration in mathematics classrooms (Balgamis, Cakiroglu, & Shafer, 2014; Handal, Campbell, Cavanagh, & Petosz, 2016). However, analysis of these studies indicated that the use of the rubric is inconsistent and sometimes does not preserve the fidelity of the instrument.

## Purpose of the study

- Unpack the performance indicators of the TPACK Levels Rubric (Lyublinskaya & Tournaki, 2012) in order to:
  - Explain the differences between the five levels of TPACK;
  - Examine what each level of TPACK represents.
- Achieve horizontal progression across the levels and vertical alignment across the components, as well as consistency of terminology throughout the whole rubric.
- Provide guidance for the assessment of preservice and in-service teachers' TPACK level for teaching mathematics and science based on various teaching artifacts.

## Background

### TPACK Levels rubric

The original TPACK Levels Rubric was developed and validated by Lyublinskaya and Tournaki (2012). The structure of the rubric was based on the TPACK development model for teacher growth for technology integration (Niess, 2006).

- The rubric is organized as a matrix, with each cell representing specific TPACK level (1 – 5) for one of the four components of TPACK (Conception, Students, Curriculum, or Instruction).
- Two performance indicators were developed for each level of each component consistent with the qualitative descriptors developed by Niess, (2006) and the Cognitive Task Analysis framework (Stein & Smith, 1998).
- The indicators assess the level of teacher and student involvement with technology.
- The score is assigned for each component independently. The original rubric guide suggested that in order to achieve a particular level of TPACK, the artifact must meet both indicators of that level for each component. Thus the lowest score across all four components determines the teacher's total TPACK score.
- This score provided a conservative measure of the teacher's level of TPACK development.

### Validity and reliability

Instrument was tested for reliability and validity with the same population. The inter-rater reliability was found to be moderate. The range of correlations between the scores of the two experts on the same components was from $r = 0.613$ to $r = 0.679$ ($p < .01$). (Lyublinskaya & Tournaki, 2012). Confirmatory Factor Analysis using varimax rotation with Kaiser Normalization was performed on two 300 mathematics and science lesson plans collected during four consecutive semesters from graduate special education pre-service teachers. The procedure confirmed the four factors corresponding to four components of TPACK for each set of lesson plans (Lyublinskaya & Tournaki, 2014).

### References


Balgalmis, E., Cakiroglu, E. & Shafer, K. (2014). An investigation of a pre-service elementary mathematics teacher's TPACK within the context of teaching practices. In M. Searson & M. Ochoa (Eds.), Proceedings of Society for Information Technology & Teacher Education International Conference 2014 (pp. 2210-2217). AACE.

Handal, B., Campbell, C., Cavanagh, M., Petosz, P. (2016) Characterising the perceived value of mathematics educational apps in preservice teachers. Mathematics Education Research Journal 28(1), 199-221.

Levy, P., Little, S., McKinney, P., Nibbs, A., & Wood, J. (2010). The Sheffield companion to inquiry-based learning. Sheffield: Centre for Inquiry-Based Learning in the Arts and Social Sciences, The University of Sheffield.

Lyublinskaya, I. & Tournaki, E. (2012). The Effects of teacher content authoring on TPACK and on students' achievement in algebra: Research on instruction with the TI-Nspire handheld. In R.Ronau, C. Rakes, & M. Niess (Eds.), Educational Technology, Teacher Knowledge and Classroom Impact: A Research Handbook on Frameworks and Approaches. (pp. 295 – 322) IGI Global.

Lyublinskaya, I., Tournaki, N (2014) A study of special education teachers' TPACK development in mathematics and science through assessment of lesson plans. Journal of Technology and Teacher Education, 22(4), 449-470.

Niess, M. L. (2006). Knowledge needed for teaching with technologies – Call it TPACK. AMTE Connections, 17, 9–10.

Stein, M. K., & Smith, M. S. (1998). Mathematical tasks as a framework for reflection: From research to practice. Mathematics Teaching in the Middle School, 3(4), 268-275.


## Study conceptual framework

The original TPACK Levels Rubric was developed specifically for assessing teacher's knowledge growth for teaching mathematics and science with technology. Therefore, Niess' model for the teacher's knowledge progression from PCK to TPACK (Niess, 2006) was aligned with the Cognitive Task Analysis (CTA) frameworks for learning mathematics (Stein & Smith, 1998) and with Inquiry-Based Learning (IBL) framework (Levy et al., 2010).

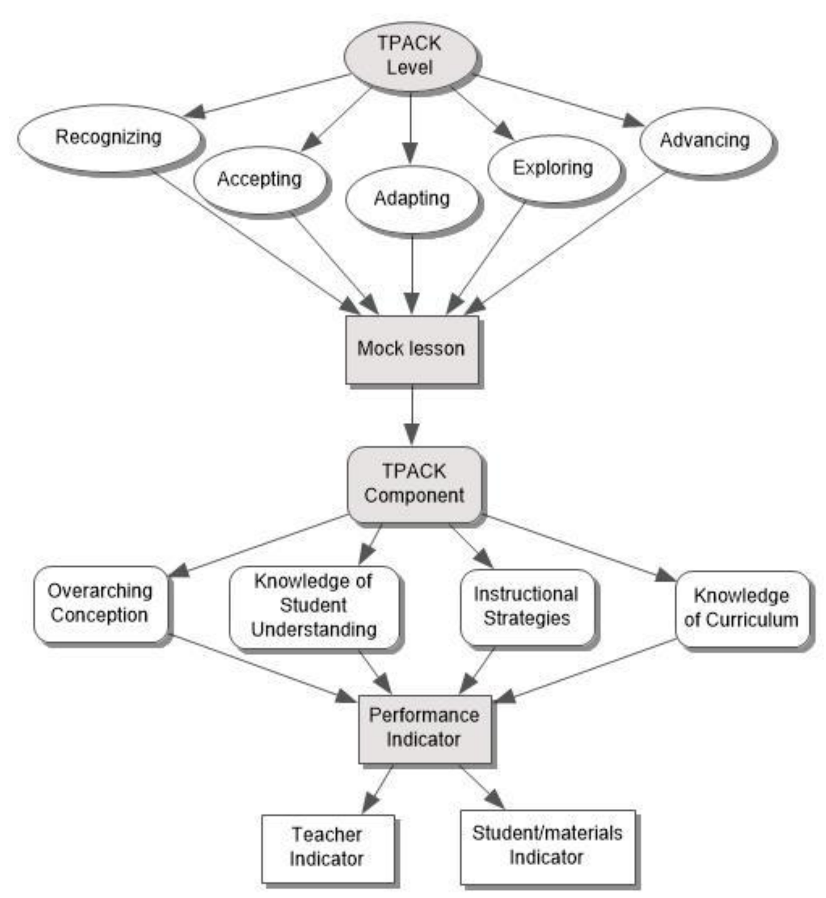
| TPACK growth model (Niess, 2006) | CTA (Stein & Smith, 1998) | IBL (Levy et al., 2010) |
|---|---|---|
| Recognizing | Memorization | No inquiry Confirmation inquiry |
| Accepting | Procedures without connections | |
| Adapting | Guided practice | Structured inquiry |
| Exploring | Guided integrations | Guided inquiry |
| Advancing | Doing mathematics | Open inquiry |

## Research methodology

Study followed systematic iterative design process to unpack, analyze, and revise as necessary the performance indicators of the TPACK Levels Rubric (Lyublinskaya & Tournaki, 2012).

### Rubric analysis process

- Developed lesson examples for each TPACK level consistent with the criteria of the original rubric.
- Examined and revised (as necessary) performance indicators for each component to achieve a clear distinction between teacher-related actions and student-related actions with instructional technology
- Analyzed and modified (as necessary) the performance indicators to achieve:
  - Horizontal progression across levels
  - Vertical alignment across the components




### Validity and reliability

- Tested with 394 K-6 mathematics lesson plans
- Factor analysis confirmed construct validity with loadings ranging from .544 to .722.
- Internal consistency of the rubric was tested using Cronbach's α. The values of α ranged from .974 to .979 for four components of the rubric with overall value of .983 indicated high internal consistency.

## Unpacking Rubric Indicators

### Mock Lesson Plan

- 2nd grade mathematics topic of addition and subtraction of numbers within 1,000 using place value and the properties of operations.
- Available technology: Smart Board with Smart Notebook software, teacher's computer with access to the Internet and LCD projector, student laptops with PowerPoint software and access to the Internet, basic calculators.

As a result of the analysis, the performance indicators were modified to maintain both consistency across different components for each level (vertical alignment) and distinction across different levels for each component (horizontal progression).

### Vertical alignment across components - Example of Recognizing level

New material is introduced by teacher without the use of technology. Teacher uses technology for motivation, and use of instructional technology does not support student thinking and learning of new material. Students use technology for drills and practice only Technology-based activities for students include inquiry tasks. Technology-based tasks do not support students in making connections between curriculum topics. Technology focuses on technology itself rather than on supporting student learning of mathematics or science.

***Overarching Conception***

| Rubric v1.0 - before revision | Rubric v2.0 - revised |
|---|---|
| • Instructional technology is used for motivation, rather than actual subject matter development. All learning of new ideas presented by the teacher mostly without technology<br>• Technology-based activities do not include inquiry tasks. Technology procedures concentrate on drills and practice only. | • Teacher is using instructional technology for motivation only rather than subject matter development. All learning of new ideas presented by the teacher mostly without technology.<br>• Technology-based activities do not include inquiry tasks. Technology procedures do not provide space for students to use or make connections. |

- Teacher uses the Smart Board when introducing the rules for addition and subtraction, however the addition of the Smart Board does not change the way students learn the topic and serves as a motivational tool only.
- Calculators are used in the student practice of addition and subtraction for just checking the answers.
- Technology is used for routine tasks which does not support students in making connections to previously learned topics.

***Knowledge of Student Understanding***

| Rubric v1.0 - before revision | Rubric v2.0 - revised |
|---|---|
| • Instructional technology is used primarily for student practice.<br>• Digital materials do not present any new material, and only provide space for applications and drills. | • Teacher uses instructional technology in a way that does not support student thinking and learning new content.<br>• Digital materials only provide space for student practice and drill. |

- The Smart Board is used by the teacher only as a projection and note writing device which does not support student thinking and learning.
- Students use an online quiz to practice addition and subtraction without using place value and/or properties of operations.

***Knowledge of Curriculum***

| Rubric v1.0 - before revision | Rubric v2.0 - revised |
|---|---|
| • Teacher does not use instructional technology for learning mathematics or science.<br>• Instructional technology if used is not aligned with one or more curriculum goals. | • Teacher selects instructional technology that is not aligned with curriculum topics.<br>• Students' tasks with technology do not support making connections between topics in the curriculum. |

- Teacher selects a SmartBoard as a writing device, rather than choosing technology that supports the effective teaching of addition and subtraction.
- Teacher's choice of giving students calculators for checking their answers for addition and subtraction problems, does not support students in making connections between operations of addition and subtraction and the place value.

***Knowledge of Instructional Strategies***

| Rubric v1.0 - before revision | Rubric v2.0 - revised |
|---|---|
| • Teacher focuses on how to use instructional technology rather than how to explore mathematics or science ideas, using teacher-directed lectures followed by student practice.<br>• Digital materials provide students only with opportunities for drill and practice. | • Teacher focuses on how to use instructional technology rather than how to explore mathematics or science ideas.<br>• Digital materials are built around drill and practice only. |

- Teacher provides students only with instructions on how to use calculators rather than thinking of how calculators can help students to apply properties of addition and subtraction to practice problems.
- The choice of an online quiz as a basic assessment tool that provides no meaningful feedback to the students.

### Horizontal progression across levels - Example of overarching conception component

***Goals for rubric revision:***

Clear distinction between teacher indicators at different levels. Clear distinction between student indicators at different levels. Clear distinction between teacher and student indicators within the same level.

| Level | Description of indicators |
|---|---|
| *Recognizing* | • Teacher uses instructional technology for motivation only.<br>• Students use technology for drills and practice only. |
| *Accepting* | • Teacher uses technology for demonstration of new knowledge.<br>• Students use technology for new knowledge without inquiry tasks. |
| *Adapting* | • Teacher uses technology in a new way allowing for students to learn new knowledge.<br>• Student technology use includes inquiry tasks and allows for making connections between major topics. |
| *Exploring* | • Mostly students use technology to experiment with new knowledge and to practice.<br>• Students are doing math or science through Inquiry tasks that use or develop connections between major topics. |
| *Advancing* | • Teacher develops technology tasks for students include inquiry task of high cognitive demand.<br>• Student inquiry activities develop deep mathematical or scientific knowledge representing connections and strategic knowledge. |

## Significance

To the best of our knowledge, the TPACK Levels rubric remains the only quantitative instrument that assesses teacher's TPACK growth.

The TPACK Levels rubric (Lyublinskaya & Tournaki), 2012) is a validated instrument that has been used in various studies to assess teacher's growth for technology integration in the classroom through five progressive levels in each of the four components of TPACK (Balgalmis, Cakiroglu, & Shafer, 2014; Kaplon-Schilis & Lyublinskaya, 2015). However, analysis of the literature revealed that the use of this tool was inconsistent across different studies. The significance of this study is in revising this instrument and providing guidance to educational researchers and practitioners to assure consistent use of this rubric in the field.

The study developed guidelines accompanied by examples on how to use the TPACK Levels rubric to assess TPACK levels of preservice and in-service teachers teaching mathematics and science in elementary school.

The TPACK Levels rubric could be used to assess TPACK development in preservice and in-service teacher education programs.

Please email the authors if you would like to receive a copy of the rubric.