Testing a TPACK-Based Technology Integration Assessment Rubric

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Abstract: Although there is ever-increasing emphasis on integrating technology in teaching, there are few well-tested and refined assessments to measure the *quality* of this integration. The few measures that are available tend to favor constructivist approaches to teaching, and thus do not accurately assess the quality of technology integration across a range of different teaching approaches. We have developed a more "pedagogically inclusive" instrument that reflects key TPACK concepts and that has proven to be both reliable and valid in two successive rounds of testing. The instrument's interrater reliability coefficient (.857) was computed using both Intraclass Correlation and a score agreement (84.1%) procedure. Internal consistency (using Cronbach's Alpha) was .911. Test-retest reliability (score agreement) was 87.0%. Five TPACK experts also confirmed the instrument's construct and face validities. We offer this new rubric to help teacher educators to more accurately assess the quality of technology integration in lesson plans, and suggest exploring its use in project and unit plans.

Developing and Assessing TPACK

New understanding of the complex, situated, and interdependent nature of teachers' technology integration knowledge—termed "technological pedagogical content knowledge," or TPACK (Mishra & Koehler, 2006; Koehler & Mishra, 2008)—has led to inevitable questions about how this knowledge can be both developed and assessed. As the summaries below demonstrate, there is considerably more variety at present among TPACK development approaches than among assessment strategies.

Koehler & Mishra (2005) recommend a learning-by-design approach to TPACK development in which educators, content experts, and technology specialists design instruction collaboratively, building TPACK as they do so (Koehler, Mishra & Yahya 2007). Other researchers promote immersive, content-based approaches, such as instructional modeling (Niess, 2005), collaborative lesson study with university researchers (Groth, Spickler, Bergner, & Bardzell, 2009), and meta-cognitive exploration of "deictic" TPACK that emerges as curricula and technologies change (Hughes & Scharber, 2008). Still others promote active, professional reflection and inquiry. Dawson (2007) and Pierson (2008), for example, suggest TPACK as a focus for teachers' action research. Mouza & Wong (2009) propose a TPACK-based case development strategy in which teachers learn from their practice. Two approaches focus TPACK development within teachers' planning. Roblyer & Doering (2010) recommend TPACK self-assessment as the first step in each stage of instructional decision-making. Harris and Hofer (2006; 2009) draw upon research about teachers' planning practices to suggest a learning activities-based approach to selecting and combining curriculum-keyed teaching/learning strategies and complementary educational technologies.

By contrast, published instruments that assess TPACK development and that have been tested for reliability and validity are of one type only: the self-report survey. Schmidt, Baran, Thompson, Koehler, Shin, & Mishra (2009) and Archambault & Crippen (2009) developed self-report instruments with multiple items keyed to each of the seven types of knowledge represented in the TPACK construct: technological (T), pedagogical (P), content (C), technological pedagogical (TP), technological content (TC), pedagogical content (PC), and technological pedagogical content knowledge (TPACK). Schmidt et al.'s survey was designed for repeated use by preservice teachers as they progress through their teacher education programs. It was also found to be reliable and valid for use at the beginning and end of shorter-duration summer courses in technology integration. Archambault and Crippen's survey instrument was designed to be used by inservice instructors, and was found to be reliable and valid with a nationally representative sample of approximately 600 K-12 online teachers.

Though the testing of these two instruments proved them to be quite robust measures, the challenges inherent in accurately estimating teachers' knowledge via self-reports—in particular, that of inexperienced

teachers—are well-documented. Unfortunately, research has shown that measured gains in teachers' self-assessed knowledge over time are more reflective of their increased *confidence* regarding a particular professional development topic than their actual increased *knowledge in practice* (Lawless & Pellegrino, 2007; Schrader & Lawless, 2004). Self-report data should therefore be triangulated with external assessments of teachers' TPACK knowledge. Since no instrument had been developed and published to date (to our knowledge) that supported this type of performance-based evaluation of TPACK, we decided to create and test one.

Instrument Origins

There are three types of data that can be used to assess teachers' TPACK: self-report (via interviews, surveys, or other generated documents, such as reflexive journal entries), observed behavior, and teaching artifacts, such as lesson plans. Since teachers' knowledge is typically reflected through actions, statements, and artifacts, rather than being directly observable, instruments and techniques that assist the assessment of teachers' TPACK should provide ways for assessors to discern the dimensions and extent of teachers' TPACK in systematic, reliable, and valid ways. Since teachers' stated pedagogical beliefs do not always align with their instructional practices (Lawless & Pellegrino, 2007), external assessment of those practices and their artifacts, triangulated with the contents of teachers' self-reports, should help us to better understand the nature of their TPACK by inference.

However, TPACK, like all types of teacher knowledge, is expressed in different ways and to different extents at different times, with different students, and in differing contextual conditions (Koehler & Mishra, 2008). Inferring a teacher's TPACK solely by direct observation in the classroom is probably not possible, since the decision-making processes that led to the observed instructional actions and interactions need to be identified so that the knowledge that undergirds those actions and interactions can be discerned. Optimally, teachers' planning, instructional actions, interactions with students, and reflections upon those actions and interactions should *all* be examined to determine the nature and extent of their TPACK. Logistically, however, generating enough of these multiple types of data is challenging, especially with people learning to be teachers, who typically have limited (and often methodologically constrained) opportunities to implement instruction that they have planned. A more feasible alternative is to analyze teaching artifacts that both demonstrate the results of teachers' decision-making, while also providing a pragmatic window into their pedagogical reasoning: their instructional plans.

A search of the technology integration literature yielded only one instrument that had been tested for reliability and validity and that can be used to assess the quality of teachers' technology integration as it is reflected in instructional plans: Britten and Cassady's (2005) Technology Integration Assessment Instrument (TIAI). The TIAI is a rubric that can be used to assess technology integration in a lesson plan across seven dimensions: planning for technology use, content standards, technology standards, differentiation, use of technology for learning, use of technology for teaching, and assessment. Since we wanted to use a robust instrument that helps assessors to infer a teacher's TPACK by examining an instructional plan, we decided to begin with this already-tested tool, then adapt the TIAI to reflect key aspects of the TPACK construct.

Given the interdependent, situated, and complex nature of teachers' TPACK, we decided to revise the TIAI to reflect demonstrated technological pedagogical (TPK), technological content (TCK), and technological pedagogical content knowledge (TPACK), along with the "fit" of selected content, teaching strategies, and technologies considered together. We chose not to include separate technology, pedagogy, or content knowledge items, given the interdependence of TPACK's elements, and the instrument's intended technology integration focus.

Instrument Testing Procedures

After requesting and implementing informally solicited advice on revisions to a draft of our rubric from about a dozen local technology-using teachers and administrators, we formally sought the assistance of six TPACK researchers from different universities to provide feedback regarding the construct and face validities of the revised rubric. After examining the rubric's items, the TPACK researchers provided focused written comments in response to seven free-response questions about the rubric. We revised some of the rubric's items, along with several aspects of its structure, according to the experts' comments.

We then asked 15 experienced technology-using teachers (described in Table 1 below) and district-based teacher educators in two different geographic regions of the United States to test the reliability of the instrument by using it to each assess 15 preservice teachers' technology-infused lesson plans. The two groups of teachers ("scorers") met at the researchers' two universities during either July or August of 2009 for a 6-hour day to learn to use the rubric, then apply it in the evaluation of each of the 15 lesson plans. The plans addressed varying content areas and grade levels, and had been created originally as responses to an authentic assignment in several sections of a preservice technology integration course that were taught by the same instructor using the same instructional approach during a two-year period. The plans' student authors had received a range of different grades from the instructor for their lesson planning work.

After the scorers used the revised rubric to each assess the 15 lesson plans, they answered the same seven free-response questions to which the experts responded earlier. We revised the rubric a third time after calculating its interrater reliability and internal consistency according to the first group of lesson plan scores, and after reviewing the scorers' feedback on the rubric itself. The second group of scorers used the newly revised rubric to score the lesson plans, then provided written feedback in response to the seven questions described above. Finally, we asked each teacher in each location to re-score the same three lesson plans via email one month after scoring them for the first time, and used these data to calculate the test-retest reliability of the instrument.

Scorer	Years Taught	Content Specialty	Grade Levels Taught	Years Teaching w/ Digital Techs.	Ed Tech PD Hours: Prev. 5 Years	Ed Tech Expertise Self-Assess.
A	5	K-8	K, 3, 5	5	70	Intermediate/ Advanced
B	9	Elementary high-level learners	3, 5, 6	3	48	Intermediate
C	8	Secondary Math	7, 8	8	90	Intermediate
D	8	Math	7-12, K-8	4	225	Advanced
E	8	Science, Physics, Astronomy, Earth Science	5-12	7	200+	Advanced
F	18	Elementary	K-8	18	250	Intermediate
G	6	Science	7-8	6	450	Advanced
H	6	Industrial Tech, Computer Information Systems	9-12	6	200	Expert
I	4	Reading	2	4	5	Intermediate
J	15	History, Social Science, English	7-12	6	85	Intermediate
K	8	English	6, 8-12	5	120	Intermediate
L	14	Language Arts, Social Studies,Library Media	K-7	14	135	Advanced
M	28	K-8 Instructional Tech	K-12 all	25	200	Advanced
N	6	Math, Social Studies	K-8, K-12	3	60	Intermediate
O	20	English, Technology Integration	Pre-K 9-12	7	850+	Advanced

Table 1: Study participants working at pseudononymous Midwestern and Southeastern (shaded) Universities.

Validity Analysis

The construct and face validities of the instrument were examined using two strategies that are recommended for rubric validation (cf. Arter & McTighe, 2001; Moskal & Leydens, 2000). Construct validity reflects how well an instrument measures a particular construct of interest, which in this study was TPACK, as it is represented in educational lesson plans. As explained above, construct validity was examined in this study using expert reviews. Face validity, or whether an instrument *appears* to informed observers to measure what it is supposed to measure, was examined using feedback from experienced teachers ("scorers") who had used the rubric to score the set of 15 pre-service lesson plans, as described above.

Construct validity was a particularly important aspect of this rubric for us to test, since it was developed with TPACK as a central and unifying construct. The six experts consulted had strong qualifications for this review process, which included extensive experience with the TPACK framework as both researchers and teacher educators. In addition, two of the reviewers authored chapters in the *Handbook of Technological Pedagogical Content Knowledge (TPCK) for Educators* (AACTE, 2008), and one has recently released a TPACK-based preservice textbook. The researchers were asked to gauge how well TPK, TCK and TPACK were represented in the rubric, how well technology integration knowledge might be ascertained overall when using the rubric to evaluate a lesson/project plan, and what changes might be made to the rubric to help it to better reflect evidence of TPACK in teachers' planning documents. The rubric's construct validity was supported strongly by comments from five of the six expert reviewers. The sixth expert did not agree that the quality of technology integration (and therefore teachers' TPACK) could be ascertained overall for any instructional plan. Instead, this reviewer suggested creating specific questions to be answered about the appropriateness of technology use in different aspects of an instructional plan, such as the communication of content, the instruction itself, and the assessment.

The rubric's face validity was determined by analyzing the scorers' feedback on both the process of using the rubric and its perceived utility. All of the scorers' written comments supported the rubric's ability to help teacher educators to assess the quality of TPACK-based technology integration inferred from lesson plan documents. Some also offered suggestions for minor changes to the wording in some of the rubric's cells, several of which were used to create the version of the rubric that appears in the Appendix.

Reliability Analysis

The reliability analysis of the rubric was conducted via two successive trials, held at Southeastern University on July 13, 2009 with seven teachers and at Midwestern University on August 4, 2009 with nine teachers. The rubric was refined and modified for the Midwestern trial based upon the reliability and face validity results from the Southeastern trial. Teachers at both locations were chosen purposively, based upon their experience integrating use of digital technologies into their teaching and their diverse backgrounds in both content areas and grade levels. Using the data generated as described above, reliability was computed for each location using four different strategies: 1) interrater reliability computed using the Intraclass Correlation Coeficient (ICC), 2) interrater reliability computed using a second percent agreement procedure, 3) internal consistency within the rubric computed using Cronbach's Alpha, and 4) test-retest reliability as represented by percent agreement between scorings completed one month apart by the same teachers.

The reliability procedures used in this study were selected in consultation with three statisticians, who also helped to interpret and confirm the resulting analyses. These contributors included: the director of the National Science Foundation's Center for the Assessment and Evaluation of Student Learning; an emeritus university-based measurement specialist; and a research professor working in a Center for Research on Youth, Families, and Schools.

Each procedure was selected for its particular advantages in the analysis of rubric (or similar instrument) reliability. For example, the Intraclass Correlation Coefficient is a relatively well-known statistic that flexibly examines relationships among members of a class (Field, 2005; Griffin & Gonzalez, 1995; McGraw & Wong, 1996). In this study the teachers scoring the lessons were essentially designated as a class, with rubric scores considered to be random effects and the teachers considered to be fixed effects for the ICC procedure. Percent agreement was also used to determine the extent of interrater reliability, and involved a systematic procedure that examined the pairing of scores from two different judges at a time on each lesson, then computing the mean percent

of agreement. Adjacent scoring was used to represent agreement, and was defined as two scores with no more than one rubric category difference. For example, rubric scores of 3 and 4 would be considered to be in agreement, while scores of 2 and 4 would be seen as out of agreement. Since percent of agreement has long been used for criterion-referenced scoring (Gronlund, 1985; Litwin, 2002), its usefulness to further check interrater reliability was clear.

The rubric's internal consistency was examined at both sites using the well-established and commonly used Cronbach's Alpha procedure (Allen & Yen, 2002; Cronbach, Gleser, Nanda, and Rajaratnam, 1972). In this procedure, the rubric scoring data set was transposed to permit an examination of the consistency of participants' scores between each of the four rows of the rubric.

To analyze the rubric's test-retest reliability, a percent agreement strategy was used again. The teachers' scores for three of the lesson plans were compared to their scores for the same three lesson plans one month later. Each individual row's score, as well as the rubric's total scores, were compared, and an average percent agreement was computed. The three lesson plans to be scored twice were selected to represent a variety of content and grade levels. They addressed elementary science, middle school English, and secondary Spanish.

Reliability Results for the Southeastern Trial

As mentioned previously, the Southeastern scoring effort was conducted first. The score for each row of the rubric was recorded individually, then a total score for all four rows was computed by adding the scores for the individual rows. Using the ICC, the resulting statistics were: Row 1 = .533, Row 2 = .464, Row 3 = .537, Row 4 = .593, and Total Rubric = .620. After the ICCs were computed, a further examination of the correlations showed one judge's scores to be only weakly correlated with that of the other judges, resulting in correlations of .20 or less on individual parings. This judge essentially scored all lesson plans consistently, and very low. When this judge was removed from the data set, than the ICC results increased to be: Row 1 = .517, Row 2 = .515, Row 3 = .578, Row 4 = .649, and Total Rubric = .646. This first set of calculations also indicated that one lesson plan of the 15 was an outlier, with a standard deviation of 3.96 for the total rubric score, as compared with the other 14 lesson plan standard deviations that ranged from 0.99 to 2.72. This also may have impacted the ICC results, albeit slightly.

Although the ICC results were generally adequate for reliability for a rubric of this length, the other reliability statistics computed were more encouraging. The percent agreement of the six judges (after the removal of the judge described above) was computed for each of the four rows and total score of the rubric. This statistic is known to be less sensitive to the "direction" of how judges' scores align. Instead, it considers exclusively how "close" judges' scores are to each other. The percent agreement for the rubric was computed to be: Row 1 = 91.1%, Row 2 = 90.2%, Row 3 = 89.3%, Row 4 = 85.8%, and Total Rubric = 83.6%. Given this statistic's conservative nature, the rubric's reliability was supported. Its computed internal consistency was also quite positive, calculated as .902 for the rubric as used at Southeastern. The rescoring results of the Southeastern data, which also used a percent agreement calculation, further supported the rubric's reliability. The percent agreement between two scorings of three lesson plans one month apart by the Southeastern teachers averaged 95.0%.

Though the rubric's reliability testing results at Southeastern were positive overall, we sought to improve them. Since the Midwestern scoring happened about a month after the session at Southeastern, there was time to try to increase the rubric's reliability by refining its wording—specifically in its "Technology Selections" row, changing "optimal" to "exemplary," and renaming "Technology Uses" to "Instructional Strategies & Technologies"—and by replacing the outlier lesson plan with a different document.

Reliability Results for the Midwestern Trial

Using the slightly revised rubric from the Southeastern scoring activity, the Midwestern scoring session occurred about a month later. A total of nine teachers started scoring, but one teacher could not complete the task due to a childcare need. Thus eight teachers fully scored the 15 lesson plans at Midwestern, following the established scoring procedures implemented at Southeastern. The lesson plans examined were the same as the Southeastern lessons, except for the one replacement described above.

Revising some of the rubric's wording, as well substituting the one lesson plan, seemed to improve the interrater reliability results, as the ICC scores were higher for the Midwestern scoring group. They were computed as: Row 1 = .817, Row 2 = .803, Row 3 = .830, Row 4 = .782, and Total Rubric = .857, which were encouraging and generally supported rubric reliability. The percent agreement results at Midwestern were similar to those from Southeastern, and supported interrater reliability with: Row 1 = 93.5%, Row 2 = 86.4%, Row 3 = 91.9%, Row 4 = 86.0%, and Total Rubric = 84.1%. The internal consistency of the rubric with the Midwestern scoring group also held up well, resulting in a Cronbach's Alpha reliability calculated at .911.

As with the Southeastern teachers, the Midwestern teachers were asked to rescore the same three lesson plans one month later, to examine rubric reliability in a test-retest procedure. The Midwestern rescoring results were similar but slightly lower than the Southeastern results, with an overall percent agreement for both groups of 87.0%. Given this conservative nature of this statistic, the result provides further evidence for the instrument's reliability.

Interpretation of Results

Given the reliability testing results using ICC calculations, percent agreement computations, and the Cronbach's Alpha measure, we conclude that the rubric has adequate reliability to recommend it for further use. In particular, the minor modifications to the rubric made after the first reliability testing seemed to enhance its reliability, as evidenced by the second set of results. The rubric's reliability calculations, along with its validity evaluations, suggests that we can confidently offer it for use by other researchers and educators.

Discussion

Since the TPACK-based Technology Integration Assessment Rubric (see Appendix) has been tested by experienced technology-using educators who were evaluating preservice teachers' lesson plan documents, and has been found to be both reliable and valid as a result, we are confident that it is sufficiently robust to be used to assess other preservice teachers' planning artifacts as part of instruction and/or research. If the rubric were to be used to evaluate experienced teachers' written descriptions of their lesson, project, or unit plans, we suspect that it would prove to be similarly serviceable. However, since the tool has yet to be tested with experienced teachers' plans, we cannot assure its appropriateness for use with more practiced educators. Similarly, we have not explored its use as a teaching observation aid, but are curious about its utility for evaluating the quality of technology integrations as evidenced by observed classroom actions and interactions, in addition to planning artifacts.

For this instrument to be maximally useful, the planning documents being evaluated need to be written in enough detail so that scorers can make well-informed choices in each of the rubric's four dimensions. Since practicing teachers typically do not write detailed lesson or project plans for daily use, an interview protocol could be developed that would glean more complete information than teachers' planbook entries usually encompass. Data generated during those interviews perhaps could then be used in lieu of written planning documents to assess the quality of technology integration using the Technology Integration Assessment Rubric.

We are pleased to place this instrument into the public domain via a Creative Commons (attribution, noncommercial) license, and encourage consideration of its use for both research and professional development. We invite our readers to share their experiences with and perceptions of the rubric using the electronic mail addresses listed above.

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Appendix: **Technology Integration Assessment Rubric**

Criteria	4	3	2	1
Curriculum Goals & Technologies (Curriculum-based technology use)	Technologies selected for use in the instructional plan are <u>strongly aligned</u> with one or more curriculum goals.	Technologies selected for use in the instructional plan are <u>aligned</u> with one or more curriculum goals.	Technologies selected for use in the instructional plan are <u>partially aligned</u> with one or more curriculum goals.	Technologies selected for use in the instructional plan are <u>not aligned</u> with any curriculum goals.
Instructional Strategies & Technologies (Using technology in teaching/ learning)	Technology use <u>optimally supports</u> instructional strategies.	Technology use <u>supports</u> instructional strategies.	Technology use <u>minimally supports</u> instructional strategies.	Technology use <u>does not support</u> instructional strategies.
Technology Selection(s) (Compatibility with curriculum goals & instructional strategies)	Technology selection(s) are <u>exemplary</u>, given curriculum goal(s) and instructional strategies.	Technology selection(s) are <u>appropriate, but not exemplary</u>, given curriculum goal(s) and instructional strategies.	Technology selection(s) are <u>marginally appropriate</u>, given curriculum goal(s) and instructional strategies.	Technology selection(s) are <u>inappropriate</u>, given curriculum goal(s) and instructional strategies.
"Fit" (Content, pedagogy and technology together)	Content, instructional strategies and technology <u>fit together strongly</u> within the instructional plan.	Content, instructional strategies and technology <u>fit together</u> within the instructional plan.	Content, instructional strategies and technology <u>fit together somewhat</u> within the instructional plan.	Content, instructional strategies and technology <u>do not fit together</u> within the instructional plan.