INSTRUMENT DEVELOPMENT TO ASSESS SCIENCE PRIMARY AND SECONDARY TEACHERS' PERCEIVED TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE

Arif Hidayat

IPSE-UPI

Introduction

Pedagogical Content Knowledge (PCK) is a construct of central concern and interest in science education (e.g., van Driel, Verloop, & de Vos, 1998; Veal, van Driel, & Hulshof, 2001; Loughran, et al., 2001). Shulman (1986; 1987) originally described PCK as "an understanding of how particular topics, problems, or issues are organized, presented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (1987, p. 8).

The TPACK framework expands on PCK by adding the dimension of *technological knowledge*. Originally described by Mishra and Koehler (2006), the current conception of this relatively new framework is best described by Koehler and Mishra (2009). Building on Shulman's conception of PCK, TPACK describes how teachers' knowledge of educational technology interacts with their PCK in ways that produce effective teaching and opportunities for student learning. This creates two new knowledge domains -- Technological Pedagogical Knowledge (TPK) and Technological Content Knowledge (TCK) – represented as areas of overlap in Figure 1. The central triangle formed where all three circles overlap is TPACK.

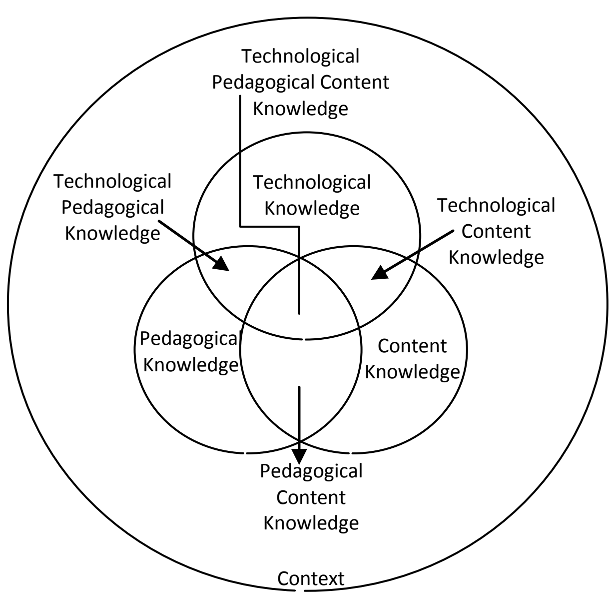

Figure 1. Koehler and Mishra's (2009) representation of TPACK, highlighting the importance of considering and defining the context in which an individual is situated.

TPACK has considerable utility for understanding teacher practice. The PCK component does an excellent job of describing the type of knowledge essential to good teaching. TCK helps one think about ways in which technology can transform the teaching of specific topics, and TPK addresses the pedagogical opportunities created through use of specific technologies. As defined, TPACK can be a useful framework for examining the impact of professional development projects on teachers' perceived knowledge. TPACK enables one to consider how growth in one knowledge domain, such as technology, interacts with the other two domains, such as content and pedagogical knowledge. Consequently, this theoretical construct enables one to explore how these interactions and TPACK varies over time or across different contexts.

At least two quantitative TPACK instruments exist in the literature to date (Archambault and Crippen, 2009; Schmidt, et al., 2009). Both were useful attempts at developing instruments based on this theoretical framework; however, both have significant limitations. The Archambault and Crippen (2009) instrument is limited in that it has only three or four items per subscale, making it impossible to adequately assess each subscale. Another limitation is that this instrument was designed for use with online teaching and has limited utility for exploring the use of other types of educational technology. An instrument created by Schmidt et al. (2009) provides more items for most of the subscales and includes many well-worded and useful questions. However, its utility is limited by the fact that it examines four content domains (science, literature, mathematics, and literacy), whereas most secondary teachers teach within a single domain. Another limitation is that this survey asks teachers to assess the extent to which they have "sufficient knowledge" about a particular domain (science, literature, mathematics, and literacy). A component of good instrument development involves posing questions that contribute to the assessment of a construct, not asking directly about the construct itself.

Data analysis is another issue. A major reason for conducting Rasch analysis is to enable researchers to use scale scores rather than raw scores for data analysis. Existing work on TPACK quantification appears to have been done using raw scores (Shin et al. 2009; Archambault and Crippen 2009). This is problematic because a fundamental assumption in using parametric statistics is that the data are linear. Because Likert-scale data are categorical, the common practice of immediately analyzing Likert-scale data with parametric statistics (t-tests, ANOVA, etc.) violates basic assumptions of statistical tests. This is one of the primary reasons why Rasch measurement is growing in use in science education research (e.g., Boone and Scantlebury, 2006; Liu and Boone, 2006).

Need clearly exists for more robust measurements of how teachers' TPACK changes over time. Calculation of such changes is particularly useful in assessing the impact of teacher professional development experiences. Many professional development projects use five to ten evaluative questions to judge the efficacy and outcomes of their entire project. Although this may suffice for project evaluation purposes, research into teacher learning requires more robust methodology. A solid instrument is needed that enables researchers to examine the use of technology to teach science in a manner that reveals important details about the impacts of a ways that are statistically and scientifically sound.

Key to the use of Rasch modeling is the idea that optimal measurement scales can best be constructed by considering the importance of single traits. Through this process, sets of items can be created that optimally measure perceived abilities of the respondents. Creating scales reduces the error of measurement of respondents and makes it possible to quantify differences between respondents. Use of Rasch techniques helps in the conceptualization of traits and also provides indices that go far beyond those typically cited in the science education literature. For example, Rasch analyses indicate reliability of both item separation and person separation. Validity of the instrument can also be tested using a range of statistics such as item fit and person fit. Rasch techniques allow potentially non-linear raw scores to be converted to scale scores, and Wright maps provide a powerful way to express the performance of respondents with regard to the latent trait. In other words, Wright maps allow respondents to be more than "just a number."

Based on the problem, I would like to conduct the research about instrument development to assess science primary and secondary teachers' perceived technological pedagogical content knowledge. The result of the research will be implemented in Science Education in Indonesia.

Goals

The research goal is to designed instrument is intended to measure teachers' perceived TPACK.

Methods

The research will be conducted by the presence of the questionnaire which is includes 79 questions, organized into seven subcategories. Like the Schmidt, et al. (2009) instrument, each subcategory relates to a specific theoretical construct within TPACK (CK, PK, TK, PCK, TCK, TPK, and TPACK – see Figure 1). Each item has responses on a six-point scale ranging from "strongly disagree" to "strongly agree." As described below, principles of Rasch Measurement were used to guide the development of the instrument. Individual items were grounded in theoretical constructs and empirical evidence of what constitutes good teaching in reference to technology, pedagogy, content and the interrelationship among these knowledge domains. The overall will be focused on measuring the single latent trait, TPACK, with each of the subscales contributing to this measurement.

An important point is that this new instrument should entail an implicit assumption that knowledge can best be understood as situated action. In other words, knowledge is best understood by what a *teacher can do within a specific context*. When viewed from a situated perspective, knowledge is seen as an active interaction among an individual, concerned with specific content, working within a specific context (Young, 1993). TPACK theory has been tied to stativity theory from the beginning (Mishra & Koehler, 2006). However, to really measure teacher knowledge from a situated perspective, one would have to conduct observations and embark on substantial qualitative analyses rather than relying on a questionnaire alone.

Item Development

The initial draft of the Perceived TPACK Instrument was guided by principles in Rasch measurement, theoretical constructs in the literature (Mishra & Koehler, 2006; Koehler & Mishra, 2009), and two existing instruments (Schmidt, et al., 2009; Shin, et al., 2009). The authors will go through a series of iterative revisions based on these measurement principles:

- Each item aimed to measure a single latent trait.
- Consistency was sought in nature and structure among all items.
- Word choice was purposeful and guided by a desire for clarity.
- The intensity of terms used was designed to be consistent across all items.
- Words were avoided that would elicit a biased a response.

After numerous rounds of revisions, a draft of the instrument will be sent to an expert review committee who are asked to comment on whether there are a) any problems with the wording of individual questions, b) any questions that did not fit within a given category, and/or c) any questions or topics missing from one or more categories. Finally, they will be asked whether the questions represent the range of abilities possessed by teachers. Feedback from the committee results in changes in individual items and the development of a standard introduction that addressed several issues, such as our definition of the term “educational technology.”

Field Testing

The Perceived TPACK Instrument will be tested with a group of 21 teachers beginning their participation in a year-long professional development experience focused on the use of educational technology to teach science. The teaching experience of these teachers ranged from 3-31 years in the classroom.

Data Processing

Rasch analysis will be conducted using Winsteps software (Linacre, 2009). Although probably the current data set is small, Rasch analysis provides insights in to the perceived knowledge of these teachers and about further steps that can be taken to better understand both group of respondents and the manner in which the instrument functions

In Rasch measurement, improved indices of reliability can be computed. These include person separation reliability and item separation reliability. For this data set and subscale, the person separation reliability will be computed to be 2.47 and the item separation reliability to be 1.94. These indices begin at 0 but do not end at 1, an improvement over traditional reporting of reliability which ranges from 0 to 1.

Finally, category probabilities will be reviewed as a function of item difficulty and person measure. The research will include an analysis of all seven subscales and the larger latent trait overall. Collection of additional data will help the researchers to test this hypothesis and to further monitor scale functioning and refine the instrument.

References

Archambault, L., & Crippen, K. (2009). Examining TPACK among K-12 online distance educators in the United States Contemporary Issues in Technology and Teacher Education, *CITE Journal*, *9*(1). Retrieved from http://www.citejournal.org/.

Boone, W., & K. Scantlebury “The role of Rasch analysis in science education utilizing multiple choice tests” *Science Education, (2006)* 90, 253-269.

Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education*, *9*(1), 60-70.

Linacre, J. M. (2009). Winsteps Computer Program.

Liu, X. & Boone, W. J. (Eds.), *Rasch Measurement in Science Education*. Maple Grove: JAM Press. (pp.137-164).

Loughran, J., Milroy, P., Berry, A., Gunstone, R. & Mulhall, P. (2001). Documenting science teachers' pedagogical content knowledge through PaP-eRs. *Research in Science Education, 31*(2): 289-307.

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A new framework for teacher knowledge. *Teachers College Record, 108*(6), 1017-1054.

Porter, A. C., & Smithson, J. L. (2001). Are content standards being implemented in the classroom? A methodology and some tentative answers. In S. H. Fuhrman (Ed.), *From the capitol to the classroom: Standards-based reform in the states, Part II* (pp. 60-80). Chicago: University of Chicago Press.

Schmidt, D. A., Baran, E., Thompson, A. D., Koehler, M. J., Shin, T. S., & Mishra, P. (2009). *Technology,pedagogy and content knowledge (tpck): The development and validation of an assessment instrument for preservice teachers*. Paper presented at American Educational Research Association (AERA) Annual Meeting, San Diego, CA.

Shin, T., Koehler, M.J., Mishra, P. Schmidt, D., Baran, E., & Thompson, A. (2009, March). *Changing technological pedagogical content knowledge (TPACK) through course experiences*. Paper presented at the 2009 International Conference of the Society for the Information and Technology & Teacher Education. March 2-6, Charleston, South Carolina.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4-14.

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, *57*(1), 1-22. van Driel, J, H., Verloop, N., & de Vos, W. (1998). Developing science teachers' pedagogical content knowledge. *Journal of Research in Science Teaching*, *35*, 673-695.

Veal, W.R., van Driel, J.H., & Hulshof, H. (2001). PCK: How teachers transform subject matter knowledge. *International Journal of Leadership in Education, 4(*3): 285-291. vol9/iss1/general/article2.cfm

Young, M. F. (1993). Instructional design for situated learning. *Educational Technology Research and Development, 41*(1), 43-58.