

Differentiating TPACK-based Learning Materials for Preservice and Inservice Teachers

Mark Hofer
Department of Curriculum and Instruction
School of Education, College of William & Mary
Williamsburg, Virginia USA
mark.hofer@wm.edu

Judi Harris
Department of Educational Policy, Planning and Leadership
School of Education, College of William & Mary
Williamsburg, Virginia USA
judi.harris@wm.edu

Abstract: Teacher educators have long noted differences between preservice and inservice teachers' knowledge, practice, and professional learning. A small number of studies have compared novice and experienced teachers' technology integration knowledge, attitudes, and intentions, with mixed results. Most TPACK research has examined preservice and inservice teachers separately. How should TPACK development be differentiated for preservice and inservice teachers? We sought experienced teachers' perceptions and recommendations about how an online short course that was developed for *novice* teachers should be changed so that it can facilitate *experienced* teachers' professional learning. Data generated and analyzed were focus group interviews, demographics, and written suggestions for changes to the short course's modules. The participating teachers' animated and detailed recommendations highlighted the need for differentiated content, sequencing, illustrations of practice, and engagement techniques.

Designing well-integrated, curriculum-based learning experiences that leverage digital tools and resources can be a challenge for both novice and experienced teachers. The Technological Pedagogical Content Knowledge (TPCK/TPACK) framework suggests that effective technology integration requires teachers to draw on multiple domains of knowledge and their intersections in practice (Mishra & Koehler, 2006). Abundant scholarship has been generated in the twelve years since the framework's introduction that helps us better understand how this knowledge develops and is enacted in classroom teaching. While this literature base is broad and varied, there is considerably more work within it that explores approaches to help preservice teachers to develop their TPACK than inservice teachers. Teacher educators have published and shared textbooks, case studies, learning activities, and a range of curricular materials to help novice teachers develop their TPACK. Comparatively fewer resources have been developed and shared for experienced teachers. How, if at all, should TPACK development approaches be differentiated for preservice and inservice teachers? How might the materials designed for novice teachers be modified to meet the needs of experienced teachers?

Comparing Technology Integration Knowledge, Attitudes, and Practices

To answer these questions, it is necessary to understand the nature of preservice and inservice teachers' technology integration knowledge, including their TPACK, and the ways in which that knowledge is applied in the classroom. If preservice and inservice teachers' knowledge and practice are more similar than different, then similar professional learning materials and approaches might be used effectively with both groups. To whatever extent they are different, however, the ways in which the development and enacting of preservice and inservice teachers' TPACK should diverge.

While considerable research has analyzed preservice and inservice teachers' TPACK during the past dozen years, it has done so primarily separately (Dong, Chai, Sang, Koh, & Tsai, 2015). In a rare comparison study, Dong and colleagues found preservice teachers in China to be less knowledgeable and confident in all aspects of their TPACK

(and also their beliefs about instructional design and constructivism) than inservice teachers, based upon factor analyses and structural equation modeling of their survey responses. These results follow a pattern that is similar to an early synthesis of research about preservice and inservice teachers' pedagogical content knowledge (PCK). Novice and experienced teachers' PCK was found to be different only (and markedly) in degree of development and assimilation. Novice teachers' PCK expanded and became less segmented over time and with increasing teaching experience (Cochran, King & DeRuiter, 1991).

In contrast, however, several studies reported significantly different attitudes toward technology integration, with preservice teachers reporting more positive perceptions and expectations, and more confidence in their abilities to integrate technology effectively than inservice teachers (Russell, Bebell, O'Dwyer, & O'Connor, 2003; Spaulding, 2010; Thomas & O'Bannon, 2015). How are these self-perceptions operationalized in practice? Interestingly, other research has discovered that despite differences in attitudes toward technology integration, experienced teachers tend to integrate a larger variety of educational technologies into their teaching; they do so more often than novice teachers (Wetzel, Zambo & Ryan, 2007); and they make better-quality instructional decisions about technology integration overall (Palacio-Cayetano, Schmier, Dexter, & Stevens, 2002). Inservice teachers' greater expertise, formed during more years of classroom experience, and probably PCK-based, is said to explain these implementation differences.

What is the nature of those differences? In analyzing and evaluating preservice and inservice teachers' independent responses to video-based cases that tested the teachers' technology integration knowledge and instructional choices, Greenhow, Dexter and Hughes (2008) found that the two groups performed similarly when making decisions regarding educational technology use. However, inservice teachers outperformed preservice teachers in the depth, breadth, and specificity of their practical, contextual, and pedagogical content knowledge. The authors characterized these differences by saying:

...the rationales upon which preservice teachers based their instructional decisions were more superficial, uncritical, and relied largely on consideration of students and [the] classroom-related facts of the case, compared to inservice teachers' responses, which were more detailed, better elaborated, more interpretive, and critical of the school context. The rationales upon which inservice teachers based their decisions also mentioned a wider range of classroom, school, and district-level factors as influential. (p. 21)

As Greenhow, et al. (2008) recommended while discussing possible implications for practice discerned from their comparison of preservice and inservice teachers' applied TPACK, there is "...a need for teacher educators to teach planning and decision-making, especially emphasizing the importance of identifying and weighing options and articulating a well-justified instructional plan" (p. 22) that integrates the curriculum-based use of educational technologies in judicious, meaningful ways. This is precisely what our learning activity types materials and instructional planning approach (e.g., Harris & Hofer, 2009, 2011; Harris, Hofer, Blanchard, Grandgenett, Schmidt, van Olphen & Young, 2010; Hofer & Harris, 2010; 2016) seek to assist teachers in doing, within the realities of classrooms, schools, and school districts.

Prior to 2016, teaching teachers how to use this approach to building and applying their TPACK while planning curriculum-based, technologically supported learning experiences for their students was done in university courses, school- and district-based professional development offerings, and publications for teachers, all supported by freely available and shareable professional materials (e.g., learning activity types taxonomies and assessment instruments) that are Creative Commons-licensed and available online (<http://activitytypes.wm.edu>). Conversations with other teacher educators who were using the learning activity types taxonomies helped us to become aware, however, of the need for a more scaffolded way to help teachers to build their TPACK using this particular approach to instructional planning, and as part of their workplace learning.

A TPACK-based Short Course for Preservice Teachers

In Spring 2016, we designed, produced, and shared a Creative Commons-licensed, self-paced online short course for preservice teachers' TPACK development. The content and design for the course are based upon our research about

leveraging learning activity types (LATs) to help preservice teachers to develop their TPACK through a scaffolded instructional design experience (Hofer & Harris, 2016). The short course comprises nine modules:

1. Introduction to the short course
2. Identification of existing lesson plans to analyze
3. Analysis of the selected lessons
4. Exploration of taxonomies of learning activity types and corresponding technologies that are relevant the user's curriculum-related practicum teaching
5. Practice using the selected taxonomy in instructional design
6. Selection of learning goals for a lesson and analysis of the instructional context in which the lesson will be taught
7. Lesson design
8. Selection of educational technologies to use within the lesson
9. Conclusion

Each module begins with an overview and stated learning goals for the segment, and is presented as video-based content that includes narrated slides, interviews with practicing teachers, imagery, and links to additional online resources. Each of the video segments are 2-8 minutes in length, and are closed-captioned. The modules also offer editable student learning guides that scaffold each step in the short course, and regular prompts for in-class or online discussion with colleagues and mentors. The short course can be used as a supplement to face-to-face instruction or as a completely online learning experience that might span two to three weeks. We have created different versions of the short course for elementary and secondary preservice teachers that contain customized classroom-based examples to maximize relevance for preservice learners. We shared the short courses as open educational resources (OERs) internationally (<http://activitytypes.wm.edu/shortcourse>) so that they can be used in conjunction with educational technology and/or teaching methods courses in teacher preparation programs.

Because we designed the short course for preservice teachers, we included rich examples and highly-scaffolded planning procedures and materials to help students to develop their own technology-enhanced lesson plans. Since this short course might serve as an early (or even the first) experience in lesson planning, we included far more "hard scaffolds" (Brush & Saye, 2002) in both versions of the short course than are probably necessary for experienced teachers. The focus of this study, therefore, was to explore how we might modify the short course to meet the needs of experienced teachers effectively. We sought the advice of experienced teachers to guide the short-course adaptations, using a systematic data-generation procedure that is described below. We then extrapolated from the modifications that the participating teachers recommended some tentative working hypotheses (to test in later research) about how designing professional learning experiences in technology integration for experienced teachers should differ from experiences designed to meet the needs of novice teachers.

The following research questions guided our study:

- 1) What, if anything, should be changed about the Learning Activity Types online short course so that it can be used effectively by experienced teachers?
 - a) What should be added?
 - b) What should be deleted?
 - c) What should be modified?
 - d) What should be approached differently?
- 2) Based on the redesign of the short course, how might the design of technology integration learning materials be differentiated for novice and experienced teachers?

Data Generation

We recruited twelve experienced teachers representing a range of grade levels and content areas, half working at the elementary level, and half working in secondary schools. We identified potential participants through recommendations from the central office of a nearby school district and through participation in a doctoral-level course being taught during the fall 2016 semester that focused on teaching and learning online. We sought to identify teachers who are interested in, but comparatively inexperienced with, integrating technologies in their teaching. We invited the twelve teachers who accepted our invitation to the School of Education for a day-long, structured exploration of the existing preservice short course, with accompanying focus-group discussion. The participants were not required to do any preparatory work for the session.

At the beginning of the day, after explaining the study and reviewing the consent form on which we requested the participants' signatures, we asked the teachers to complete a brief demographic survey that included their number of years teaching; subject areas taught currently; gender; and extent to which they integrate use of educational technologies into their teaching and their students' learning currently (Choices: multiple times per day, daily, several times per week, weekly, and less often than above). We also asked them an open-ended question, requesting that they respond in writing: "How, if at all, do you think that learning to integrate technologies into teaching is different for experienced teachers versus preservice teachers?"

We provided a brief description of and rationale for the online short course for preservice teachers and answered questions from the participants. We then watched each of the modules from the preservice online short course together on a large screen, one at a time. We provided the participants with a printed verbatim script for each of the modules and encouraged them to make notes or comments on these documents as we viewed the videos and documents, suggesting changes to be made when adapting the short course for use by experienced teachers. We collected these handwritten notes on the module scripts from the participants for later review and analysis.

We also provided the participants with a printed list of the questions that guided the focus group discussion after we watched each module together:

- What, if anything should we delete from this module for it to be helpful to experienced teachers?
- What, if anything should we add to this module for it to be helpful to experienced teachers?
- What, if anything should we modify about this module for it to be helpful to experienced teachers?
- What, if anything should we approach differently in this module for it to be helpful to experienced teachers?

We completed the focus group interview by asking two open-ended questions:

- Thinking back on what we have discussed today, overall, what kinds of changes are necessary to make these modules helpful to experienced teachers?
- Any other advice that you would like to share as we plan to adapt these modules for experienced teachers?

We audiorecorded, and later summarized the content of the focus group discussions. We also transcribed representative verbatim segments of the participants' responses to these questions for each of the nine modules. These actions prepared the data for analysis.

Data Analysis

Immediately following the focus group session, after the participants left, the two researchers met to generate initial theme possibilities from notes that were taken during the discussions conducted earlier. We then set these theme

possibilities aside until after we analyzed the transcribed and summarized data more closely. We then reviewed the data, with the research questions serving as referents. We analyzed the data holistically and thematically by question, noting possible themes. We then met together to share the emergent themes that we had surfaced independently, comparing them with the initial themes generated together immediately after working with the participants. This discussion helped us to collaboratively draft the study's findings.

We then summarized the collaboratively discerned study results and sent them to the study's participants as an email attachment, with the following member checking request:

Attached is our summary of what we think we learned from you during our session. Please change anything that we've written here that you remember differently and add anything that we've missed. If you have thought of any additional suggestions for changes to the modules, please send those to us, also.

We met again to develop the study's findings that are shared below.

Results and Discussion

The twelve participants ranged from 7 to 28 years of teaching experience, with an average tenure of 17 years in the classroom. Ten of the participants were female and two were male. Four participants taught in elementary schools, four in middle school, and four in high school. Ten of the participants were currently teaching full-time, and two were in their first semester of full-time graduate study, having left full-time teaching only a few months before the feedback session occurred. All of the participants reported using technology daily in their teaching. Nine reported using technology multiple times during each day's instruction.

Overall, three ideas that were embedded in the short course's design, structure and approach resonated with the study's participants. A concept introduced in module three, then explored in later modules in increasingly greater depth, is the notion of "fit" (Harris & Hofer, 2011). We describe *fit* as the degree to which a particular digital educational tool or resource connects with and supports both the curriculum focus and chosen pedagogical approach for a learning experience. In essence, identifying "fit" challenges teachers to draw on all three interdependent forms of knowledge included in the TPACK construct. "Fit" seems to be how the teachers understood TPACK, in a grounded, practical way.

Similarly, teachers responded enthusiastically to a strategy introduced in module eight that helps teachers to self-assess the in-practice quality of an idea for technology integration: the "Is it worth it?" test. They appreciated the realistic, student-centered and classroom-focused nature of this self-assessment, comparing it favorably with the more tool-centric approaches they experienced in much educational technology professional development.

A unique aspect of the LAT approach is its sequencing of technology-related decisions during instructional planning near the end of the suggested planning sequence that was introduced in module eight. While the teachers participating in this study were surprised about technology choices being made toward the end of the instructional planning process, they agreed that considering technology options later, rather than earlier, would probably lead to better-integrated, more student-centered and curriculum-based learning designs. However, given their basis in reflection upon longtime classroom-based teaching experience, we suspect that these three over-arching ideas may resonate better with experienced teachers than with preservice or novice teachers.

Learner Engagement

At the end of viewing each short course segment, or module, we asked the teachers what they would recommend that we change to make the module more effective in supporting experienced teachers' professional learning. Participants offered a number of suggested changes, from very minor and predictable suggestions (e.g., remove language that references preservice teaching) to more substantive and, in some cases, fundamental revisions.

Many of the suggested changes emanated from the assumption that experienced teachers would probably not encounter these modules as part of an organized university course, as preservice teachers do. Rather, the study's

participants assumed that eventual teacher-users would more likely work through these modules either to support their own informal learning, or perhaps as a part of a school-based professional learning community (PLC) or professional development (PD) experience. Consequently, many participants suggested changes that are focused on making the materials as engaging and appealing as possible. Many of the teachers argued that it is critical to “draw teachers in,” and then keep them engaged with compelling ideas and demonstrations of those ideas throughout each module. The participants were imagining eventual short-course users more as critical consumers than as students required to complete the modules for a course. For example, one participant noted,

I think a nice graphic right at the beginning is important. I know I can click through twenty things looking for something and I look at that first shot. If it doesn't look good to me, I move on to the next tool. So, maybe [insert] a graphic of what you'll explore on the whole site before you even introduce yourselves.

Another teacher commented,

If I could look at this site and go “Wow, once I open this one link I'll have social studies, I'll have science, I'll have math. And this is a resource I can go to for many different lessons.” That might be something that makes me save it to my tab bar.

We realized that these comments represent a much different mindset than that of a student in a teacher preparation program whose course grade may well depend, in part, on successful completion of this short course.

A related suggestion from the experience teachers focused on the need to identify the learning goals and outcomes clearly that teacher-users could expect from completing the short course. Several teachers suggested that these goals and outcomes should be listed prominently on the first page of the short course's website. They argued that without providing this information and featuring it prominently from the beginning of the course, many teachers would leave the site without taking the time to review the different modules. As one teacher explained,

I think in the beginning there should be a way to preview exactly what's going to happen in each section. Most of the time when teachers are lesson planning they're looking for fast things. So, if, for example, they're more interested in how to analyze lessons, [they will wonder]: “What is that about? Can I just skip to that? Can I do that portion of it without spending hours getting there?”

Several of the teachers also suggested that a rich multimedia experience is key to keeping participants engaged in the short course. They suggested adding many more informational graphics and animations that illustrate concepts and ideas, with each image remaining on the screen for no more than a few seconds. One teacher noted, “Some of the still pictures can be enhanced even if it was just motion and not sound and maybe if you were talking over it... I think [that] would be more engaging for the audience.” The teachers strongly preferred video to text and/or audio, suggesting a greater proportion of classroom footage to “talking heads,” even if those were classroom teachers. They stressed the importance of adding more “real examples” and “real people” to the short course. In brief, our participants wanted to be able to explore classroom-based examples in which they could watch real teachers modeling the use of specified learning activity types and technologies with students.

Modeling and Demonstration

Related to the desire for more animations and moving images, the teachers expressed a strong preference for modeling and demonstrations. In fact, we were surprised by the degree to which even these experienced teachers wanted multiple examples, didactic modeling, and illustrations of the learning activities and technologies, applied in different content areas and at differing grade levels.

For example, in the preservice short course, when the LAT taxonomies are introduced for the first time in module four, we quickly scroll through one of the taxonomies in a screencast video as we verbally provide an overview of its structure and content. One teacher suggested,

As you're scrolling through [a sample LAT taxonomy], is there a way to kind of highlight as you're saying things, like the column headings? We need the modeling as teachers. At least I do. It helps me to see what I'm looking at.

The teachers also expressed a strong preference for multimodal presentation of the concepts introduced in the course. One suggested,

Everything you're saying verbally should be shown on the screen... You're giving all this great instruction, but obviously you know how to do it. It would help for you to highlight or point to it. Just like we do for students... "For example, here's three areas, and this is how I would change them."

The teachers similarly suggested that the modules be even more explicit in stating expectations and providing guidance before users are asked to apply new concepts in practice. One teacher summed this concern, saying, "I want to see what you're asking us to do before I have to do it." Another teacher remarked, "It's a scaffolding step for what we're going to do next."

Less surprisingly, participating teachers also wanted concrete, practical ideas that they can take away from the short course, modify and put into practice. One thinking tool in particular seemed to interest the participants. In module seven, a series of classroom context considerations is introduced in the form of a set of continua. Placing indicators on each of the continua encourages teachers to consider contextual variables including time, student groupings, and whether the learning experience would build on students' prior knowledge or serves to introduce them to a new concept or idea. The continua are presented in a static form as part of a downloadable lesson planning template. One teacher commented, "I really like the [contextual continua] template. It's something that teachers can take away." Another participant suggested, "I would make it electronic so that you can slide it along. 'I have this much time, etc.' It just narrows down your learning activities." A third participant commented that this "sliding piece" approach "...could [go] so quickly to just kind of get you started, but you don't have to write anything down."

Honor Experience, but Differentiate.

Despite their preferences for modeling and demonstration as discussed above, participating teachers asserted the importance of honoring teachers' experience and providing options to personalize professional learning according to this experience and concomitant expertise. The teachers suggested eliminating several components of the modules that, while important and helpful for preservice teachers, might be unnecessary or even insulting to ask experienced teachers to complete. For example, in module four, we encourage participants to go through a number of steps to become acquainted with an LAT taxonomy of their choosing. The teachers suggested that while it would be helpful for preservice teachers to read the introductory text and list familiar and unfamiliar LATs in the taxonomy, it would be an unnecessary and frustrating step for more experienced teachers to do this.

Similarly, in module three, participants are encouraged to analyze three existing lesson plans from a collection of options according to their stated learning goals and activities. Participating teachers agreed that while it may be interesting to examine existing lessons, this kind of detailed analysis of another teacher's plans would not be appropriate for an experienced teacher. As an alternative, one participant suggested that we say: "Take one of these lessons and make it your own. Does this fit the needs of your classroom? Now look at the lesson – how would you change it using the activity types to fit the needs of your learners?" Some of the participants even suggested eliminating the entirety of module six, which focuses on developing, analyzing, and sequencing learning goals.

In addition to removing or modifying existing activities in the modules, several of the teachers suggested that we provide options for experienced teachers to work through the short course in different ways. They noted that experienced teachers are not a homogenous group. They bring different knowledge, experience and needs to this professional learning experience. One teacher commented,

There's a wide range of experienced teachers. I think we're more on the upper end, but we're forgetting that there are other experienced teachers [who] are still struggling with all of this stuff. Or maybe their evaluations showed that they need to go back, and so the administrator can say, 'Maybe you need to take this course and go through all the modules.' Or maybe you would present it at a curriculum meeting where we all are working on the same lesson and you can modify it. Or bring your lesson plan with you and work on it. If there's a way you can leave some of those options open.

To assist teachers in customizing the way they approach the short course, one study participant suggested, “On the main page you could offer different recommended course sequences.” The participants also suggested that teacher-users review the short course’s “table of contents” to familiarize themselves with the content before they begin working with any module. In this way, our advisors suggested, they can “customize it and just do the parts that apply to them.” Yet another teacher stated,

I’m not sure how I would do this on my own. I’m liking the idea that this is something I could do with a couple of peers. There’s no way I would do these by myself, because I need someone to talk to. It’s definitely something at this point that I would at least want to have one other person I’m experiencing this with.

She suggested that we encourage teachers to consider working through the modules collaboratively with one or more colleagues.

Where’s the Technology?

When we designed the LATs short course, we purposefully introduced technology-related instructional decisions at the end of the planning process, so that students’ curriculum-based learning needs and selection of learning activities are the primary focus in instructional planning (Harris et al., 2010). This helps to avoid a “technocentric” approach (Papert, 1987) to technology integration planning. This approach, however, differed significantly from the teachers’ experience with and expectations for technology-focused professional development. As we progressed through the modules, some the teachers kept asking, “Where’s the technology?” – not realizing that it would be the last of the instructional decisions made. In the discussion that followed, we realized that the teachers were immersed in school settings that reinforced an affordances-and-constraints approach to technology integration (Kennewell, 2001), rather than a curriculum-based, learner-centered approach.

Before reaching the module that presented guidelines and examples for technology selections, participating teachers expressed puzzlement over the positioning of technology as the last set of decisions during instructional planning. One teacher commented, “If you’re taking this course and you know that [technology integration is] the focus, you’re wondering, “Why isn’t she talking about it? Where’s the technology?” At first, several of the teachers said that they wanted to see examples and have opportunities to consider possible technologies earlier in the short course. One teacher said, for example,

I’ve got my lessons. I’ve been working with these lessons. I really want to know how I can make the technology engage my students. So I am ready for the technology stuff... I want to jump here at this point. I don’t want to analyze my lessons.

Another added, “I’m coming now with this [curriculum and pedagogy] knowledge already. I need the knowledge of ...the technology I can use. I would think that anybody who’s seeking how to integrate [technologies] is ready for that step.”

In response, we explained our argument for positioning the technology selections much later in the short course, and during instructional planning. Once we were explicit about our reasons for this approach, many of the teachers expressed enthusiasm and excitement. They suggested that we present this “anti-technocentric” argument at the beginning of the short course, then quickly present the taxonomies, including references to the technologies that they suggest, so that short course users will see how the different types of teachers’ knowledge are incorporated relative to technological decision-making. One teacher who seemed to struggle with her technology-focused expectations throughout the day explained,

It took me a while to get this. It’s not the technology you’re focusing on in the modules. It’s on developing great lessons, then seeing how technology can enhance those lessons... This statement has to be at the forefront [of the short course].

Several participants expressed strong agreement with our approach. They had seen examples of technocentric thinking and planning, and acknowledged that focusing primarily upon technological affordances and constraints often led to poor lessons and projects. As one teacher noted, “No amount of technology makes a bad lesson good.”

Implications

We generated the focus and design for this study because we wanted to learn how to adapt the short course that our preservice teachers had been using to the needs and preferences of experienced teachers, and to discover whether such an adaptation would be of value to our preservice teachers' more experienced colleagues. While the twelve experienced teachers who were so kind to spend a day with us certainly taught us much about how to adapt preservice learning materials to fit the needs and interests of inservice teachers, we were quite surprised to also learn – from their realizations about their technocentric expectations for educational technology-related professional learning – just how much school district-based teacher educators' approaches to professional learning for technology integration is still technology-focused and technocentric (Papert, 1987).

The teachers' excited discussion of this realization led them to characterize much of their educational technology-related professional development to date as "Here's a tool; here's what it's good for. Now go find places in your curriculum to integrate it." They saw the short course's approach (and, we would argue, the TPACK construct's emphasis) as a truly "different option" that can help teachers to, as one participant said, "...create [learning experiences] that you wouldn't have [created] if you had taken one of your own lessons and tried to shoehorn in the technology."

Considering the participating teachers' realizations about their professional learning experiences in technology integration, we were reminded just how much work teacher educators still have to do in helping even very experienced inservice teachers to develop and enact their TPACK.

References

- Brush, T. A., & Saye, J. W. (2002). A summary of research exploring hard and soft scaffolding for teachers and students using a multimedia supported learning environment. *The Journal of Interactive Online Learning*, 1(2), 1-12.
- Cochran, K. F., King, R. A., & DeRuiter, J. A. (1991, April). *Pedagogical content knowledge: A tentative model for teacher preparation*. Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL.
- Dong, Y., Chai, C. S., Sang, G.-Y., Koh, J. H. L., & Tsai, C.-C. (2015). Exploring the profiles and interplays of pre-service and in-service teachers' technological pedagogical content knowledge (TPACK) in China. *Educational Technology & Society*, 18(1), 158-169.
- Greenhow, C., Dexter, S., & Hughes, J. E. (2008). Teacher knowledge about technology integration: An examination of inservice and preservice teachers' instructional decision-making. *Science Education International*, 19(1), 9-25.
- Harris, J., & Hofer, M. (2009). Instructional planning activity types as vehicles for curriculum-based TPACK development. In Maddux, C. (Ed.). *Research highlights in technology and teacher education 2009* (pp. 99 - 108). Chesapeake, VA: AACE.
- Harris, J. B. & Hofer, M. J. (2011). Technological Pedagogical Content Knowledge (TPACK) in action: A descriptive study of secondary teachers' curriculum-based, technology-related instructional planning. *Journal of Research on Technology in Education*, 43(3), 211-229.
- Harris, J. B., Hofer, M. J., Blanchard, M. R., Grandgenett, N. F., Schmidt, D. A., van Olphen, M., & Young, C. A. (2010). "Grounded" technology integration: Instructional planning using curriculum-based activity type taxonomies. *Journal of Technology and Teacher Education*, 18(4), 573-605.

Hofer, M. & Harris, J. (2010). Differentiating TPACK development: Using learning activity types with inservice and preservice teachers. In C. D. Maddux, D. Gibson, & B. Dodge (Eds.). *Research highlights in technology and teacher education 2010* (pp. 295-302). Chesapeake, VA: Society for Information Technology and Teacher Education (SITE).

Hofer, M., & Harris, J. (2016). Open educational resources (OERs) for TPACK development. In M. Searson & M. Ochoa (Eds.), *Proceedings of Society for Information Technology & Teacher Education international conference 2016* (pp. 4865-4870). Waynesville, NC: AACE.

Kennewell, S. (2001). Using affordances and constraints to evaluate the use of information and communications technology in teaching and learning. *Journal of Information Technology for Teacher Education*, 10(1-2), 101-116, doi:10.1080/14759390100200105

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

Palacio-Cayetano, J., Schmier, S., Dexter, S., & Stevens, R. H. (2002, June). *Experience counts: Comparing inservice and preservice teachers technology-integration decisions*. Paper presented at the National Educational Computing Conference, San Antonio, TX.

Papert, S. (1987). *A critique of technocentrism in thinking about the school of the future*. Retrieved from <http://www.papert.org/articles/ACritiqueofTechnocentrism.html>

Russell, M., Bebell, D., O'Dwyer, L., & O'Connor, K. (2003). Examining teacher technology use: Implications for preservice and inservice teacher preparation. *Journal of Teacher Education*, 54(4), 297-310. doi:10.1177/0022487103255985

Spaulding, M. (2010). The influence of technology skills on preservice and inservice teachers' perceived ability to integrate technology. In J. Sanchez & K. Zhang (Eds.), *Proceedings of e-learn: World conference on e-learning in corporate, government, healthcare, and higher education, 2010* (pp. 2193-2202). Waynesville, NC: AACE.

Thomas, K., & O'Bannon, B. W. (2015). Looking across the new digital divide: A comparison of inservice and preservice teacher perceptions of mobile phone integration. *Journal of Technology and Teacher Education*, 23(4), 561-581.

Wetzel, K., Zambo, R., & Ryan, J. (2007). Contrasts in classroom technology use between beginning and experienced teachers. *International Journal of Technology in Teaching and Learning*, 3(1), 15-27.