Developing Technology-Rich Teacher Education Programs:

Key Issues

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Chapter 1
Thematic Considerations in Integrating TPACK in a Graduate Program

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ABSTRACT

The integration of technology into classrooms is an increasingly important issue in America's schools, and at the core of this integration is the training of teachers. Teacher educators seeking to impact teachers' use of technology should recognize the needs of these learners as well as their knowledge as practitioners, in order to expand their knowledge and help them think about technology in creative ways. In this chapter, the authors describe the design and implementation of the Master's program in Educational Technology at Michigan State University (MSU) as an example of an institution's attempts to improve their facility to incorporate technology into the classroom practice. The authors briefly define the concept of the TPACK and how that theoretical model is important in thinking about technology with teacher practitioners, and how it helped to focus the design of the Educational Technology program at MSU. The authors then outline central TPACK themes that run through each of the stages of this program, and how each level, in turn, informs the others. Finally, the chapter offers concrete examples of TPACK in practice at each stage of the Master's program in educational technology.

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INTRODUCTION

The professional development of teachers has historically focused on the development of teachers' knowledge of content along with pedagogical moves that might be implemented (Lawless & Pelligrino, 2007; Wilson & Berne, 1999). As computers, the Internet, video games, and other newer technologies have been infused into the lives of students, so too have they been added into the educational repertoire of schools and other educational institutions. As new technologies have emerged, educators have sought the best path towards implementation, both in terms of the educational value gained by the learner as well as the development of a teaching force that is able to fluently navigate this changing educational landscape (Lawless & Pelligrino, 2007).

In some cases, that path to implementation has been met with resistance on the part of teachers unfamiliar with the technology and thus unwilling to utilize the full potential of the tools (Bauer & Kenton, 2005; Cuban, Kirkpatrick & Peck, 2001; Ertmer, 2005; Keengwe, Onchwari & Wachira, 2008). Administrators, support staff, and IT professionals have had a role as well, as they have often been unwilling or unable to offer the support and infrastructure necessary for the success of these initiatives. As a consequence, technology integration plans ranging from Interactive Whiteboards to 1-to-1 laptop initiatives have floundered. It is not the technology itself that is at issue, but rather the theoretical grounding of the implementations. In the end, the infusion of technological tools and innovations into the classroom must be firmly situated to both intersect and inform the teachers' existing pedagogical and content knowledge.

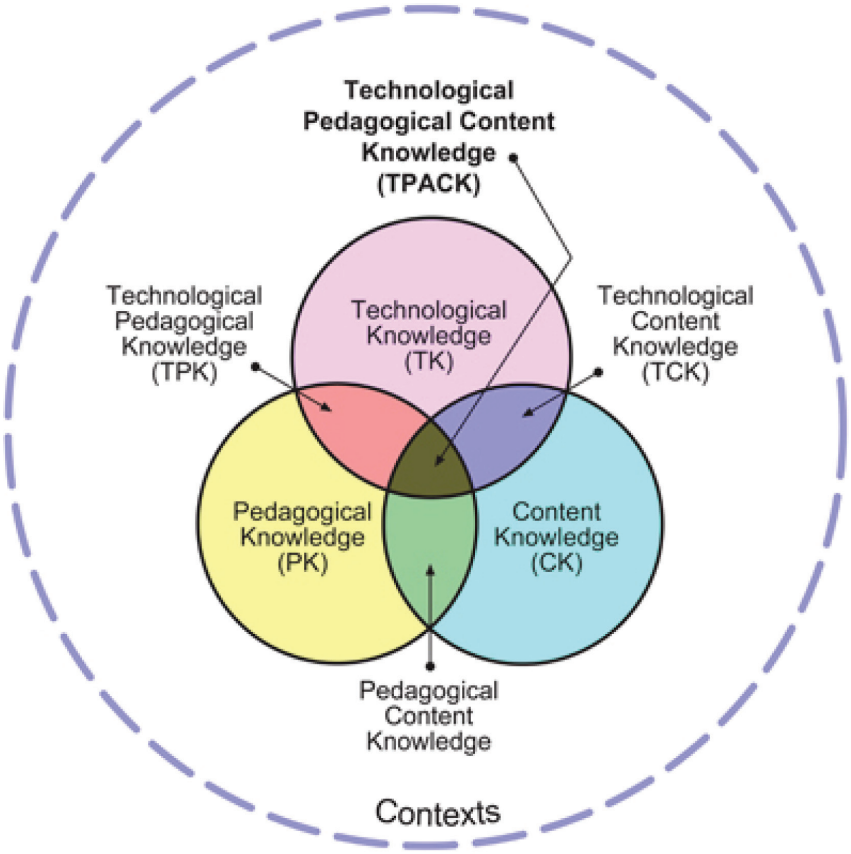
Why TPACK for Professional Development of Teachers?

The TPACK framework (American Association of Colleges of Teacher Education, 2008; Koehler & Mishra; 2008; Mishra & Koehler, 2006), initially described by Mishra and Koehler (2006), helps to conceptually ground technology-integration initiatives by anchoring the issues in the context of teacher knowledge. Building on the work of Lee Shulman (1986) on Pedagogical Content Knowledge (PCK), the framework conceptualizes how teachers' pedagogical and content knowledge interacts with technology.

In this framework (see Figure 1) three areas of teachers' knowledge are depicted: content knowledge (CK), pedagogical knowledge (PK), and technology knowledge (TK). What is most important about the framework is the ways in which these areas intersect and inform one another, so that one might focus on teachers' technological pedagogical knowledge (TPK), or the ways in which the knowledge of best practices and the knowledge of the technology combine so that a teacher implements the technology in a way sure to impact student learning, for example. When all three are combined for TPACK, what we have is a framework in which the teacher's knowledge is combined to produce strong teaching of the content that utilizes technology in a way to ideally produce and enhance student learning (Harris, Mishra & Koehler, 2009; Koehler & Mishra, 2008; Koehler & Mishra, 2010; Mishra & Koehler, 2006; Mishra & Koehler, 2008; Mishra & Koehler, 2009).

The Master's program in Educational Technology at MSU has been designed with TPACK in mind in two key ways. First, the program allows teacher practitioners an opportunity to grow in their own TPACK. Second, the TPACK framework inspires the design of the courses themselves, so that the instruction models the very ideas that we would like the teachers to utilize in their own practices. In this way, TPACK is both part of the learning outcomes and the way in which those outcomes are met. This mutually informative cycle not only improves the ways in which the teachers gain TPACK, but also meets their needs as adult learners in a graduate program.

Figure 1. The standard representation of The Technological Pedagogical Content Knowledge (TPACK) Framework. Figure retrieved from http://www.tpack.org

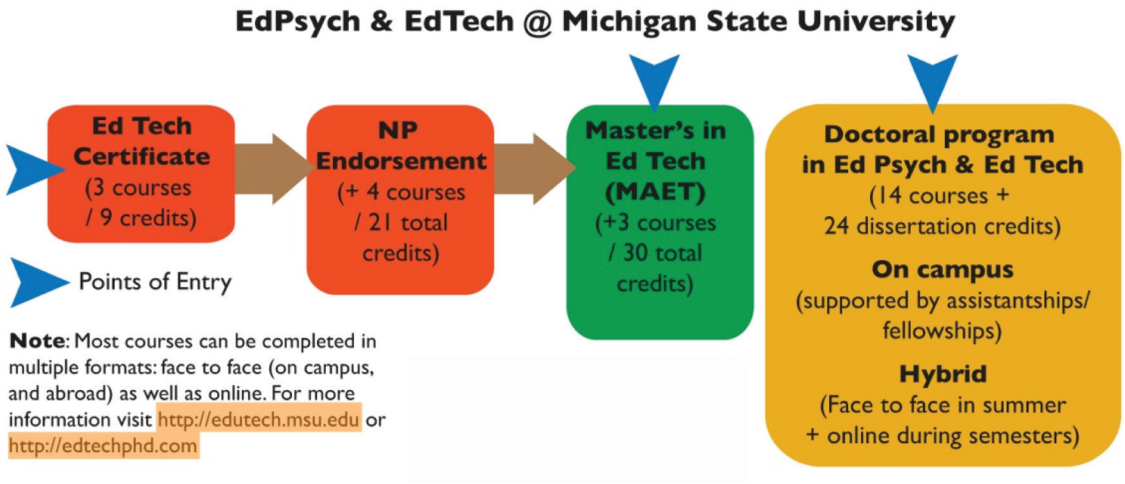


The Master's Degree Program in Educational Technology at MSU

Michigan State University's land-grant status enables outreach and support unlike that of other institutions. The College of Education is additionally uniquely situated: a leader in the nation, the college also trains and places the top-teaching candidates in the state. As part of the certification process, students are enrolled in Masters level courses, which, in turn, puts them on the road to earning their Masters degree as part of their re-certification process, moving from the early-career certification, known as the Provisional Certificate, to a Professional teaching certificate. Furthermore, the State of Michigan encourages the procurement of subsequent endorsements. In response to the need for teachers to advance their education in order to remain certified, the Masters of Ed Tech program developed multiple pathways in order to best meet these types of requirements for Michigan's teachers. While there are many entry points to the pathway (see Figure 2) generally one can conceptualize the program as beginning with the Certificate program and advancing through to the Ph.D.

The program offers multiple delivery styles with which the students might engage. First, there are traditional, on-campus face-to-face cohorts. Additionally, there is the hybrid option: a month of face-to-face instruction either on Michigan State's campus or at satellites (for instance, this

Figure 2. The structure and relationship between various programs offered by the Educational Psychology and Educational Technology program offered by the College of Education



past summer saw a cohort meeting in Rouen, France). Finally, students may opt for an entirely online experience both for the certificate and for the Masters. This flexibility carries into the Ph.D. program, for students who pursue that degree, so that there are hybrid and face-to-face cohorts at the doctoral level as well.

TPACK THEMES RUNNING THROUGHOUT THE ED TECH MASTER'S PROGRAM

In terms of both the implementation and modeling of TPACK throughout the Educational Technology program, a number of themes emerge that run through each of the courses at every level, from certificate to doctoral level courses. In essence the program seeks to *go beyond technocentrism,* to helping teachers think creatively about *repurposing technology* for educational purposes through a process of *design* instantiated in a *spiral curriculum* that culminates on their *reflecting* on their experience to become better professionals. While these themes are discussed as distinct here, it is not true that in practice they are also distinct. The themes not only inform one another, but also are interwoven throughout the program sequence. Each of these themes developed from the theoretical grounding in TPACK, and together these themes provide coherence to the courses in the program.

Theme 1: Beyond Techno-Centrism

Certainly, when discussing teachers' implementation of technology into their practice, it is important that teachers have some fluency with particular technologies and tools (Hew & Brush, 2007; Mishra & Koehler, 2006). It is our view, however, that the lack of strong technology integration in classrooms is caused, in part, by the over-reliance of techno-centric based professional development: workshops and programs which never move beyond the "how-tos" of the technology in question. When the focus becomes on the on the technology and tools, to the exclusion of all other considerations, the true potential of the integration is lost. This fetishization of technology, whether it be laser discs or Twitter, results

in narrow implementation of technology, if it is implemented at all (Koehler, Mishra, & Kereluik, 2009). When the shine wears off of the new tool, it is abandoned and those who were skeptical have reason to resist future efforts to implement the next, shiny tool.

By presenting the technology as it influences, and is influenced by, pedagogy and content, helps teachers consider technology in relation to pedagogy and content. The following questions all help de-emphasize the tool itself, and instead focus on more important issues: "How might I introduce this tool my students?"; "How might advocate to my administrators and to parents that this tool will enhance the learning?"; and "What tool best complements my existing pedagogy and meets the content goals for my learners?" The real danger, of course, in techno-centrism is that the tools are constantly evolving, being replaced, or disappear altogether. At that point, the goal of the Ed Tech program is for the teachers to be theoretically nimble enough to adapt to the ever-shifting technological landscape.

There are a variety of ways in which the master's program is designed to go beyond a techno-centric approach. For example, at the core of the MAET program is a set of courses that focus on the psychological and developmental aspects of learning. The key here is to understand that the use of technology in educational settings need to be framed within a deeper knowledge of theories of learning and development, the kinds of misconceptions students have and how these can be addressed pedagogically. One assignment that captures our approach is the "Understanding Understanding" project. This project pushes our teachers to develop an awareness of the kinds of entrenched, well-developed naïve conceptions and knowledge structures that learners have and how these can often interfere with what they are taught in school. Groups of in-service teachers, on a topic of their choosing: (1) Examine prior research of the common conceptions or alternate conceptions of their topic; (2) Develop research questions and an interview protocol; (3) Select and interview a variety of students to demonstrate understanding and misunderstanding from different ages and perspectives; (4) Edit a video to demonstrate a variety of understandings about the topic; and (5) Create a web page for the project, along with a summary of what they learned. The project follows a very specific design process in its unfolding, in order to encourage the in-service teachers to do the same with their own teaching. At the same time, we emphasize creative construction of a Web-based summary of the project as well as creative editing of the video clips. The project highlights various affordances of digital video that make the final presentations more easily understood and compelling to its viewers.

During this project, groups have interviewed a variety of subjects on a range of topics: where shadows come from, thunder, the color of blood, and how people view money. For instance, in the project about shadows, eight people were interviewed, ranging in age from 2 to 29 years. Interviewees answered questions for the camera, and also drew pictures of their own understanding (or misunderstanding) of the concept of shadows. They were asked: Where do shadows come from? Do objects/things have shadows all the time? Do you have a shadow at night? How about in a dark room? Can you touch or step on your shadow? They were then asked to draw a picture showing how a shadow works, and to explain their thought process while drawing. Based on these interviews, an engaging and informative video was constructed to demonstrate the concepts of misconception and contradiction. In this video, it was clear that students between the ages of 2 and 7 were able to contradict themselves regularly in their explanations, a development the group determined to be an invaluable lesson for teaching this age group. Another recent project took on the rather common misconception people have about our sense of taste. This video showed how the idea of "dedicated taste areas on our tongue"

is a historical myth and yet one that remained in textbooks even today.

Here the technology is used as a tool to get at the deeper goal of understanding the students' understanding, or seeking patterns in what is found and representing it in an engaging and effective manner. There is little direct instruction about the technology (audio and video editing software, website authoring platforms, etc.) as most of the discussion in class is about the development of research protocols to get students' understanding of the selected topic.

Theme 2: Repurposing/Creativity

One fundamental human trait is the ways in which we are constantly changing and adapting the environment to our needs. People use (or re-use) everyday things for purposes they were never intended for. Be it a piece of red tape to mark a glass door so that people don't slam into the glass or use a chair to prop open a door—these are examples of everyday creativity. This phenomenon can be described in different ways (particularly in the context of educational technology), everything from situational creativity to repurposing to *jugaad*. In brief, there is no such thing as an educational technology. What we have are a range of technologies that we can repurpose, re-see, and re-envision as being educational technologies. Be it using an audio editing tool such as Audacity as a data analysis tool or a GPS device to teach mathematics, teachers are designers of experiences for their students. Teachers are designing experiences that allow students to engage with the world, gaining deep knowledge of the content in the process. But these technologies don't come as a given, with their pedagogical purpose stamped all over them. Educators have to work on "re-seeing" them for their own educational purposes (Koehler, Mishra, & Kereluik, 2009).

The idea of creative repurposing is important because most technologies that teachers use have not been typically designed for educational purposes. Technologies including standard productive or office software, blogs, wikis, and GPS systems were not designed for teachers, and as such, teachers must re-purpose them for use in educational contexts. Such repurposing is possible only when the teacher knows the rules of the game, and is fluent enough to know which rules to bend, which to break, and which to leave alone. This requires a deep experiential understanding, developed through training and deliberate practice of all the aspects of the TPACK framework and how they interact with each other.

In the Master's program, we try to make these experiences with repurposing technologies both implicit and explicit ones for teachers. For instance, students in our program are explicitly asked to learn about technologies and then repurpose them for educational ends. One example is when students in our program have explored the use of micro-blogging in the classroom Micro-blogging (Twitter is a good example) involves participants sharing short messages (often less than 150 characters) with each other using a website or some other micro-blogging specific tool. We have found that using a system like this is a wonderful complement to face-to-face discussions in a classroom where everybody has a laptop. It is interesting to note here that whether or not students should have access to laptops (and the Internet) in class has been quite controversial. There are many professors who have banned them from their classrooms arguing that access to these technologies is distracting to students. In contrast, we have found that micro-blogging (within an appropriate pedagogical frame) can enhance the classroom in useful and engaging ways. We have tried this in both doctoral seminars and in undergraduate classrooms with various levels of success. The important thing to remember here, particularly given the TPACK framework, is that a technology such as micro-blogging does not exist in a vacuum. Its appropriate use has to be scaffolded by specific pedagogical instructions and guidelines. For instance, in an undergraduate

classroom, providing specific goals, and times when and for how long to micro-blog were found to be useful. In a doctoral seminar on the other hand setting such boundaries was less of an issue. What *was* important in both contexts was constructing a "space" within the class-time where these student-generated comments could be discussed. Without this the micro-blogging activity remains divorced from the actual class routines and thus can be relatively ineffective.

Another student generated example has to do with using specialized search engines (particularly visual search engines such as Viewzi, Cuil, or Clusty) to help students understand the idea of intertextuality—i.e. that texts often refer to each other in complex and intricate ways to create webs of meaning. Students use these search engines to find webpages containing a target phrase they have chosen—a famous line (such as "daggers in men's smiles" from *Macbeth*), an adapted famous line (such as "method to his madness," adapted from a line in *Hamlet*), the words of a book title (such as Joseph Conrad's *Heart of Darkness*), or a character's name (such as Grendel from the epic poem *Beowulf*). As students explore their search results, they see first-hand how words and phrases are borrowed, re-combined, and re-circulated, and they reflect on how the same words can mean different things in different contexts. As they crisscross the Web, students also begin to formulate hypotheses about vectors of influence, processes of transformation, and dynamics of popularity. Of course this could be as easily be done with a standard search engine such as Google, but the advantage of some of these visual search engines is the manner in which these links are represented. These engines offer represent search results, not in the text based series of links as Google commonly does, but with tag-clouds or visual icons. Similar search "hits" are often clustered together allowing students to view at a glance how citations can cluster together, thus scaffolding a students developing understanding about how certain texts "work together." Combing such a search with freely available bookmarking tools such as iBreadcrumbs allows students to not just record their navigation through hyperspace but also annotate them. These itineraries and annotations can then be shared with others and the teacher and be the basis for further discussion about the nature of intertextuality (and also offer interesting possibilities for student assessment).

There are many more examples we could provide here, such as an innovative use of Google Translation to teach foreign language, where the often error-ridden nature of computer translation is actually used to help students develop better understanding of grammar and metaphor. What is important here is to note that in each of these cases, the technology was not constructed for educational purposes. Making it an educational technology required creative input from the teacher to re-design, or maybe even subvert the original intentions of the software programmer. This would not be possible without a deep, complex, fluid and flexible knowledge of the technology, the content to be covered and an appropriate pedagogy. Teachers need a to develop a willingness to play with technologies and ideas, and an openness to the construction of new experiences for students.

Viewing teachers' use of technology in this manner emphasizes the role of the teacher as a producer (a designer), away from the traditional conceptualization of teachers as consumers (users) of these tools. When teachers are able to flexibly navigate the landscape of technology, pedagogy, and content, they become responsible for the total curriculum, the Total PACKage (TPACK) as it were, and thus help achieve the full educational potential of these cool tools.

Theme 3: Design

The idea of learning by design is key to the development of TPACK. Though we do have direct instruction on TPACK (more now than before) our overall guiding principle is to have people engage in authentic design activities with push

them to understand the transactional dynamic between T, P & C. micro AND macro design activities. Design also represents the complex reality of practice with more fidelity than top-down approaches. Like teaching with technology, design requires a balancing act between a wide-range of factors that often work against each other (features vs. cost, ease of use vs. advanced features, time to market vs. product quality, etc.). It requires the application of a wide array of knowledge, including algorithms, understanding of users, rules of thumb, scientific "facts," and multidisciplinary connections.

For example, in order for teachers to come to understand the value of design, we have had teachers work in groups to make two *iVideos* (idea-based videos) to communicate an important educational idea (Wong, Mishra, Koehler, & Siebenthal, 2007). Topics for the videos included: the role of technology in the library sciences, affective communication on-line, and appropriate uses of technology. Instead of learning the de-contextualized skill of creating and editing digital video, the teachers had to learn the technology within the context of communicating their understanding of larger ideas that form the basis of their profession.

Students spent most of their time in groups discussing or debating their idea, storyboarding, filming, digitizing, editing, revising, and soliciting feedback. The instructors scheduled regular times for the whole class to preview the participants' work in progress and receive feedback. Versions of their iVideos were posted to a web site so that feedback from other masters' level courses could also serve as an impetus to change and re-design. Once the movies were complete, they were shown to an audience of approximately 80 other people involved in the summer session, and were posted to the web site so that people outside the summer school could also participate in the viewing and feedback.

The design approach often results in classrooms that look and feel quite different than traditional university offerings. This was especially true in this case. The teachers were never all in one place, and spread to other rooms of the school, the hallway, outside, and any other place they could find room to talk, film, edit, storyboard, discuss, screen, and preview video. These activities went well beyond class time, teachers worked late into the night in the lab, in their dorms, and through the weekends.

Given that there was no list of skills teachers needed to learn, nor was their grade based on learning specific skills, the list of technologies that were learned was impressive. These included skills such as, learning to operate digital cameras (still and video); learning to use video and image editing software (such as iMovie, Adobe Premiere and Adobe Photoshop), learning to conduct internet searches as well as uploading and downloading files (through FTP or other means); and learning to design web pages using software such as Dreamweaver or FrontPage. Apart from these specific skills, teachers also learned key concepts in information technology, such as internet protocols, file formats and structure, video compression technologies (CoDecs) and so on.

More important than the individual technology skills was their learning about the subtleties and relationships between and among tools, actors, and contexts. Technology was learned in the context of expressing educational ideas and metaphors. Teachers learned a lot about how to focus a message down to just two minutes of video, how to let images and symbolism convey ideas in an effective manner, how to inspire audiences, work together in groups, give and receive feedback, and communicate with audiences.

Theme 4: Spiraling

The idea of spiraling, or that each concept is considered and engaged at each level of the program, is core to the philosophy of the Ed Tech program. For example, the idea of online collaborative composition might be taken up in the first few courses of the program (the Certificate level)

by introducing various tools to facilitate the collaboration and ensuring that the students are able to engage and fully manipulate the tool. Later in the program, the idea of collaborative composition would be revisited in terms of the theoretical and pedagogical reasoning behind engaging with such a tool and students would be encouraged to view the tool in terms of the way it might inform and enhance the teaching of the content. In this way, teachers are exposed to the technologies in way that allows them to play and engage with the tool as well as provide them an understanding and language for *why* the technology might be beneficial for their own students' learning. Additionally, this type of spiral recurrence of the idea both honors the TPACK that the teachers bring as well as growing that knowledge in a way that respects their individual grade assignments and content areas.

One example is an assignment known as the "55-word short story." Students are instructed to write and post a short story in 55 words. They are then to read and respond to their classmates' fiction. It is seen mostly as a quick, fun activity in which students practice interacting online. The end of the course culminates in a web design project, a project that involves many hours of creation and revision. As the students are refining their web design project, students revisit the purposes behind the short story: that choices within the confines of a web site or a short story are made with similar considerations. Re-reading the purposes behind the short story in light of the web design project show students the ways in which ideas inform and influence each other, and how all of these theories, tools, and practices are inter-related.

Theme 5: Reflection

Reflection projects are a chance for students to bring together their experience with all the different assignments and courses they have been doing in an integrated fashion so as to allow them to reflect on their own learning and think of ways to apply their developing understanding of TPCK to their own classroom contexts. Thus these assignments go beyond helping students focus on specific course-related tasks and move them towards stepping back and reflect on the total PACKage. In these projects students look backwards *and* forwards, reflecting on their learning and developing strategies to continue to learn and explore even after the course or program is over.

For example, in one assignment called the *TPACK related DreamIT grant proposal*, teachers in the program identify a problem of practice, use the TPACK framework to address the problem, and create a web-based experience that presents his/her problem and solution to his/her peers as well as explains the thinking process that led the student to the solution as opposed to others. Hence, there are two goals of the project: (a) have students tackle a specific, authentic problem and practice and consider a plan for a solution, and (b) share their problem, plan, and the thinking that went into it with a larger audience (i.e., represent it on the Web).

Students come up with very divergent authentic problems of practice and very creative projects both in terms of applying the TPACK model to their problem of practice and their Web-based ways of representing their problems and "solutions". For example, John (not his real name) sought to address how he could help students engage in higher order thinking in an English class when students' educational conditioning focused on memorization and the idea that an answer is either right or wrong. In applying the TPACK model, John initially began with searching for how technology could be a solution to this problem. However, John had already integrated a great deal of technology into his teaching. Hence, he concluded he needed to change his pedagogy to work within his context, with this curriculum, and with the technology he was already implementing. In contrast, another student, Liz also arrived at technology as a solution to her problem of practice – teaching social studies in a way that

makes it come alive and challenges just what is written in textbooks. Specifically, she chose to focus on Christopher Columbus for her TPACK project. Using an inquiry-based approach, Liz felt her technology options were limited, but eventually found an appropriate WebQuest that aligned with her pedagogy and curriculum.

The goal in these larger reflections on the Total PACKage projects is to develop the kinds of deep situated knowledge that is an essential characteristic of mastery. Clearly the work the students do in these projects does not guarantee mastery but it does set them up to look deeply into the ingrained patterns of teaching subject matter with technology, to play with these ideas and their relationships with each other, develop possible solutions and reflect both on their effectiveness and on their personal evolution as teachers. It is through this iterative process of play and design with Technology, Pedagogy and Content, and the contexts within which they are embedded that our teachers develop their TPACK.

IMPLICATIONS AND SUGGESTIONS FOR OTHER PROGRAMS

The thematic considerations described here are intentionally flexible and reflect the dynamic nature of the technologies themselves. This model is both unique and replicable, both reflecting the local MSU context at the same time as global enough to work across varieties of communities, countries, and delivery methods.

Indeed, it is this combination of consideration of the local context while maintaining universal flexibility that makes these thematic considerations ideal for other programs looking to strengthen TPACK within their own graduate programs. Whether it be a strictly teacher education/professional development program (as the one at MSU) or even one more tightly focused on a particular content area, the five themes outlined in this chapter can be instructive for any program seeking to improve the technological knowledge of their students. As every content area experiences its digitization, teachers and pre-service teachers need to successfully navigate the attending transformation of how they do science, or math, or history within that changing technological context. By grounding teacher development in the ideas of TPACK and executing programs with similar thematic considerations, the specific content area demands can also be met in light of technological change. As technology integration becomes more and more seamless, the expectation will be that professionals will already have the tools to utilize their knowledge within these digital realms.

Graduate programs would do well to consider how they encourage thinking beyond techno-centrism, how they encourage an ability to repurpose technology in ways that support the goals of the program and the learners, and how the program deals with issues of design. Additionally, by spiraling these various ideals throughout the duration of the program and supporting student reflection, graduate programs can readily enhance their own students' TPACK.

CONCLUSION

The five themes of TPACK weaving throughout the masters program, while discussed distinctly here, mutually inform one another and, in practice, are not generally seen or implemented on their own. When TPACK is both the theoretical model on which instructional decisions are based as well as the content understanding that the students achieve as they progress through the program, the result is the dynamic interaction between these five themes.

Because the Master's program in Educational Technology at Michigan State University is aimed at helping expert teachers, with their own important set of professional understandings of the interaction of technology, pedagogy and content knowledge in the classroom, our program finds itself engaged in different types of conversations

than if we were dealing with strictly theoretical concerns. It is our goal that that teachers enrolled in our program will learn and interact with an idea or a technology and immediately incorporate that into their classrooms, sometimes the very next day.

With professional knowledge also comes professional entrenchment, and it is the ways in which creativity and reflection is fostered that breaks that entrenchment. It is a familiar refrain heard from those working with professional teachers: that's a nice idea, but that won't work with my students. The balance between honoring teachers' professional knowledge and lived experiences and also pushing teachers to move beyond the boundaries of their current practice is a delicate one. It is through the thoughtful implementation of TPACK and the resulting themes that we find that balance in the Master's in Educational Technology program at MSU.

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ENDNOTE

[1] Contributions of the first two authors to this article were equal. We rotate the order of authorship in our writing.