Paper to be presented at SITE 2015 Conference

Technology, Models, and 21st-Century Learning: How Models, Standards, and Theories Make Learning Powerful

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Abstract: This paper describes the variety of educational technology models, how they all fall short in some ways, and how they can be used together to form a powerful integrative model that can be used to evaluate technology applications in the classroom. The integrative model is a tool to help teachers think about and improve their use of technology. It combines the best of various models, including SAMR, TPACK, Technology Integration Matrix, and more.

Introduction to Models

How can we think about making learning better with technology? Most technology integration starts with a piece of technology and a lot of excitement. We throw it into the classroom and declare it a success because it motivates our students. Then, we do it again…and again…and again, and the students aren't so excited about it anymore. We find that the technology is just a fancy tool replacing what we were doing before. This is where the SAMR model comes in (Puentedura, 2014). The S stands for Substitution. Too much technology is a simple substitution for what we are doing before. "But wait!" I hear you cry. The technology is making this better. Perhaps, the video clip linked to your PowerPoint is better than you droning on and on. Maybe you have reached the A in SAMR: Augmentation. But that is probably giving the video too much credit and the outstanding and engaging lecturer not enough (see, e.g., Buzbee, 2014). And still, it doesn't come close to Modification or Redefinition.

This is what makes SAMR powerful. It forces us to ask if we have truly changed the lesson with technology or if we are just tinkering around the edges. SAMR's limitation is its technology focus; we want to focus on learning. It is possible to modify a lesson or even redefine the lesson in a way that doesn't help students learn. We don't want to throw away SAMR but combine it with a model of learning. We want to think about how our students can be increasingly challenged to use technology in deep and meaningful ways that support higher-order thinking. As Liane Wardlow (2014) says, "Though I would never argue that there is no room for 'lower level' activities that only require students to attend and remember, or 'lower level' instructional activities that only use educational technology as a substitute – I would like to suggest that students would benefit from instruction that increasingly focuses on higher-level cognitive actions and lessons that are redefined by technology."

Carrington (2013) has created a Padagogy Wheel that combines Bloom's Taxonomy with SAMR. It shows the intention behind SAMR, not just modification for the sake of modification, but modification (and redefinition) for the sake of higher-order thinking. The wheel includes some apps that might be useful in implementing these higher levels of SAMR, but many are likely to be gone by the time this paper is published (and the apps by themselves aren't enough to improve learning). The power of these models is that the apps aren't the goal; the thinking and learning are the goal. A new app will come along, and this model helps to figure out how it fits in.

As teachers think about infusing technology in powerful ways, models like SAMR and Bloom's Taxonomy and tools like The Padagogy Wheel are quite helpful, but these models are not enough. They are great places to start because they put the focus on the student, but teachers need help to create learning environments that support powerful learning. That leads to a model like the Technology Integration Matrix (TIM) developed by the Florida Center for Instructional Technology at the University of South Florida (n.d.) and adapted by the Arizona K12 Center (2012). TIM combines levels of technology integration into the curriculum with characteristics of the learning environment. Characteristics of the learning environment are not specifically about technology, but the kinds of powerful learning that technology can enable and facilitate. The five characteristics are: active, collaborative, constructive, authentic, and goal directed. While the matrix describes these characteristics in terms of technology, these are goals of good learning. Jonassen (2000) describes meaningful learning as active, constructive, intentional, authentic, and cooperative (pp. 11-12). These characteristics form the basis of the vertical axis of TIM.

Sandholtz, Ringstaff, and Dwyer (1997) describe a progression with technology from Entry to Adoption to Adaptation to Appropriation to Invention. These are the basis for the horizontal axis of the Technology Integration Matrix: Entry, Adoption, Adaptation, Infusion, and Transformation. These five stages not only provide a depth of integration of technology; they also provide a path of growth. That is, we can't expect a teacher to go from no use one day to invention/transformation the next. Instead, like moving up the levels of SAMR, a teacher can progress through the stages one step at a time from struggling with technology and behavior issues at the Entry level to smoothly using technology to make the classroom more efficient at the adaptation level to redefining the way students are learning in a constructivist manner at the invention/transformation/redefinition level.

Another teacher-focused model is the TPACK model (Mishra & Koehler, 2006) that focuses on the kinds of knowledge that teachers need: technological, pedagogical, and content knowledge. This model emphasizes the overlap of these areas. That is, knowing the subject matter (content) is important for a teacher and knowing how to teach is important (pedagogical) and knowing technology (technology) is important, but it becomes more powerful when a teacher has pedagogical-content knowledge (knowing how to teach, not just in general, but the specific ways that a particular subject can be taught), technological-content knowledge (knowing the technology that applies to a specific content area), technological-pedagogical knowledge (knowing how to teach with technology), and technological-pedagogical-content knowledge (knowing how to use technology to teach a particular subject area). For example, wait time (pausing after asking a question) is a valuable pedagogical tool that applies to all content areas and a word processor is a fine piece of technology. But combing probeware with spreadsheet software (technology) to collect and analyze data (content) and helping students use that data in scientific analysis (pedagogy) combines knowing the technology with knowing how to use it to teach. That is, it combines teaching methods of data analysis with technology of data analysis in ways that specifically help students understand content. The problem with this model is that it doesn't make value judgments on the kind of learning that takes place. However, it is a powerful model about the kinds of knowledge that teachers need.

One final model, is the trudacot model proposed by McLeod and Graber (2014) to start by thinking about the purpose of a learning activity, asking the question "Technology for the purpose of what?" This is followed by a series of questions that help the teacher think about if the technology is being used to achieve that purpose. The trudacot model doesn't provide answers, but these questions are used as a catalyst to think about how to use technology appropriately and move through the levels of other models: from substitution to redefinition, from lower-order thinking skills to higher-order thinking skills, from entry to transformation, and from isolated knowledge to technological-pedagogical-content knowledge, or as Fullan (1991) says, from symbolic change to real change.

Combining SAMR, Bloom's Taxonomy, TIM, TPACK, and trudacot, we have five powerful models that help us think about what students should know and do, what teachers should know and do, and some ideas about how to get there. This paper will help explain how the five models can be used together to promote powerful learning environments that use technology effectively.

Extension, not Criticism

As Mishra & Koehler (2006) suggest: "We are sensitive to the fact that in a complex, multifaceted, and ill-structured domain such as integration of technology in education, no single framework tells the 'complete story'; no single framework can provide all the answers. The TPCK framework is no exception. However, we do believe that any framework, however impoverished, is better than no framework at all." We include this quote here to make clear that this paper is not a criticism of any of these models but a combination and extension of them. There is something to be said for simplicity and many situations where any of these simple models are better than our complex model, but the simplicity makes them too easy to tend to oversimplification.

Further, we appreciate but reject Green's (2014) argument that the SAMR is not research-based. It is a valuable tool. As Mishra & Koehler (2006) suggest, "Theories, frameworks, or models can be seen as conceptual lenses through which to view the world. They help us in identifying objects worthy of attention in the phenomena that we are studying, highlighting relevant issues and ignoring irrelevant ones" (pp. 1043-1044). While SAMR might not have emerged from years of work with teachers, it is a valuable lens through which to study technology use in schools and through which to help pre-service and in-service teachers question and refine their practice.

All of the models generally aim toward the same goal from different angles, but educators need to move from simplicity to complexity to ensure that they use all the tools at their disposal to reach that goal.

Tool-Centered vs. Purpose-Centered

There are many charts that list tools that are useful for certain kinds of learning. The Padagogy Wheel (Carrington, 2013) and the Bloom's Taxonomy Pyramid (Leonard, n.d.) are good examples. It is a very useful exercise to think about the kinds of tools you might use to think in different kinds of ways. At the lower levels of thinking, it is often easy to see how the tools fit into lower-order thinking and would be difficult to use for higher-order thinking. For example, a flashcard tool like Cram (http://www.cram.com/) is unlikely to be used for anything other than remembering. Additionally, higher-order thinking tools often match well with higher-level purposes. However, higher-order tools tend to be more open ended, making it easy to co-opt the tool into lower levels of thinking. This is why the trudacot model lays out a series of questions about the purpose of what you want to do. These questions can help lead to different tools, but the trudacot model doesn't focus on the tools at all.

A chart like the Padagogy Wheel can be used to start with the purpose. That makes it powerful when used in conjunction with the trudacot model. Asking specific questions about what you are doing and why you are doing it can help you understand for what level of Bloom's Taxonomy you are aiming. Then, a glance a the Padagogy Wheel or Bloom's Taxonomy Pyramid or a curated Web site like https://www.graphite.org/or https://edshelf.com/ can help you explore some tools that might fit that. This follows the idea of "activity types" (Harris & Hofer, 2009). If we know what our purpose is for doing an activity (trudacot), we can think about the kinds of activities that meet that purpose (activity types) and can explore technology tools that help us do that (Padagogy Wheel). Then, the real power comes from circling back and asking follow-up questions about whether our technology is really meeting that purpose (trudacot). Figure 1 shows a visual representation of this. We can start at any place on this circle as long as we end up questioning whether the tools and activity structures truly meet our purpose and truly serve the appropriate level of higher-order thinking and student-centered learning.

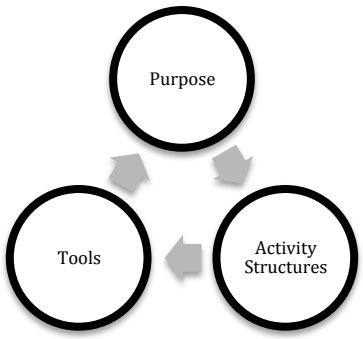

Figure 1: Circular Model

The difficulty with creating a new model is that none of these ideas are entirely new. The creators of the other models probably think about and use their models in the same way we are thinking about this model. But that leads to wondering why so many people have taken so long to think about educational technology in these ways, or, perhaps more importantly, why so many people use the models to justify mediocre uses of technology. We have seen many projects in which teachers in our classes have developed a lesson in which students use the Web to gather facts from pre-determined Web sites, answer more-or-less specific questions with those facts, and present them using some technology (such as PowerPoint). They claim that this, at least, reaches the Modification level of the SAMR Model when it is not clear that it has gone above Substitution.

A brief example: QR codes are placed around the room to look up information on Web sites and fill in a worksheet. TPACK might say, that the technology (QR codes and Web sites) are used to combine as a powerful pedagogical tool to help students understand content. SAMR might say that we have modified the structure of the classroom to actively engage students by moving around. For another example, imagine students interpreting a period in history by using ComicLife to create a dialogue among four main characters in history. SAMR might say, "The use of Comic Life would fall under the modification level of the SAMR model. Using Comic Life allows for significant functional change in the classroom. Rather than asking the students to simply summarize the outcomes of the Treaty of Versailles, we are asking them to create a cartoon strip on the computer. This activity is still asking students to engage in higher order thinking just in a different way. A common classroom task of summarizing is being transformed through the use of the computer and technology. Completing this assignment online allows for both peer and teacher feedback and easy editing." (This quote is taken from a project created by teachers for a

graduate class and used anonymously with permission.) This might sound powerful, but the example given was a comic with four characters giving a one-two sentence summary of their positions as speech bubbles but no real dialogue. The models were co-opted to justify the use of technology for low-level purposes. We do not suggest that Mishra, Koehler, or Puentadura would be happy with these interpretations of their models, but we do suggest (citing many similar encounters with our graduate students) that these kinds of interpretations are common, allowing the most mundane activities to be in the center of the TPACK model and at or near the top of the SAMR model.

This might lead us back on our circle to the trudacot question, what is the purpose. If the purpose is to get a deep understanding of the motivations of the actors in the Treaty of Versailles, the speech bubbles in ComicLife have probably failed. We might continue on our circle, to choose a different app, or we might figure out a better way to use ComicLife. We might even engage the SAMR model to explore the true meaning of Redefinition and move away from (or at least supplement) our original purpose and redefine the task to think about how the actors' motivations can be used to understand a modern-day conflict, such as between Russia and the Ukraine or between the mayor of New York and the police union or between two rivals within the school. When the lens of each model is used together, we are not merely justifying our use of technology but examining it and re-imagining it. We don't simply ask, "What is the purpose?" (trudacot) but use our models to imagine what new purpose we might have.

Schön (1983) states, "When someone reflects-in-action, he becomes a researcher in the practice context. He is not dependent on the categories of established theory and technique, but constructs a new theory of the unique case" (p. 68). This leads us to expand our model to put in explicit places for evaluation and reflection (see Figure 2). While evaluation and reflection are continuous and happening at every point of the model, they become powerful when given the explicit goal of questioning the purpose of the lesson and reflection on the new pedagogical capacity the use of technology creates for the students and teacher. Rather than a change, this is a synthesis of the previous models. Figure 3 shows how the previous models fit into this model at each point around the circle.

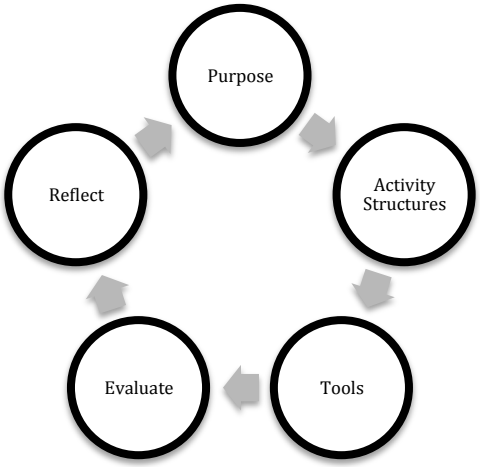

Figure 2: The PATER Model

Starting Places: Is It OK to Start with Technology?

One powerful part of this circular and reflective practice is that it is not important where you start. Any starting place could easily be refined or rejected at any point in the process. Mishra & Koehler (2006) suggest:

> For instance, one of the most frequent criticisms of educational technology is that it is driven more by the imperatives of the technology than by sound pedagogical reasons. Our framework argues that, though this can often be problematic, it is not necessarily a bad thing. Newer tools and technologies often offer possibilities that could not have been envisaged earlier. Teachers and educational technology scholars who understand that there is a relationship between technology and content .... understand that, for example, there is no simple relationship between content and technology. Technology and content exist in a continually evolving relationship, sometimes driven by newer content-related ideas that emerge and at other times by newer technologies that allow for different kinds of representations and access.. (p.1044)

A teacher might start with ComicLife, as in the above example and explore the affordances that that technology might provide to help meet some predetermined purpose. But as the purpose is brought into question, the teacher might find that the technology has to be used in a different way or rejected altogether.

By constantly reflecting we might be finding that what we were trying to measure is not what we wanted to measure. In the example above, are we trying to measure our students' understanding of the Treaty of Versailles, or are we trying to help them create a framework to understand the world? If they can't remember the particulars of the key actors but they have used the Treaty of Versailles to think about the gangs in their school, is that what we want, and, if so, is it measurable? That is, the reflection cycle helps teachers to look beyond whether they are meeting a particular objective and to call into question the purpose of the lesson and possibly the larger purpose of their class and education in general.

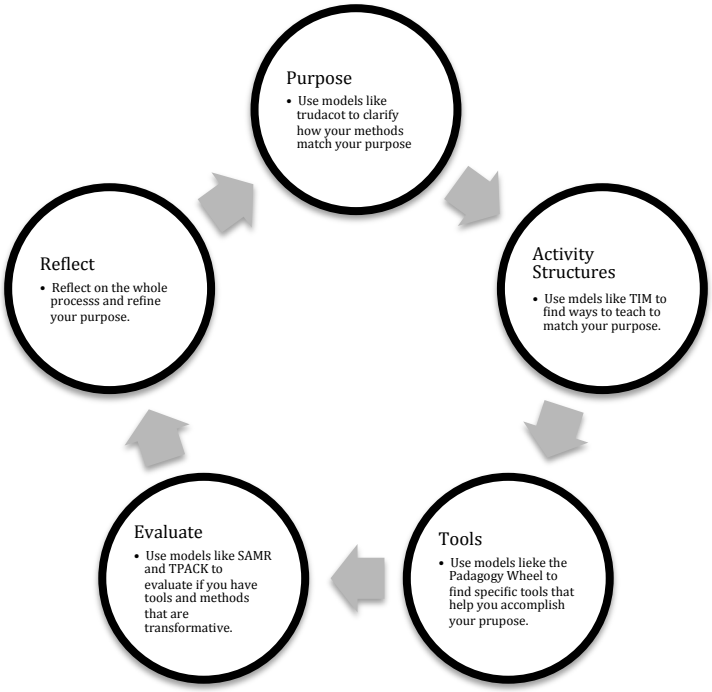

Figure 3: The PATER Model Expanded

Capacity Building

With many models, there is an endpoint. This model is intentionally circular. You might even think of it as a spiral staircase. Every trip around builds capacity for the next time around the circle. A teacher with limited technology skills might find new tools that help them improve student learning. At first, they might use these tools at the substitution level. Through evaluation, they might discover that, reflect and think about how they might tweak their purpose. Now, they are armed with some new skills and might see more possibilities in the ways they can teach and use a different activity structure. Again, they might find some additional tools that cause them to think differently about the lesson. At each step, they are building capacity for the next step, not only adding to their technology toolkit but also thinking about new ways of teaching and learning (possibly moving toward a more student-centered environment), expanding higher-order thinking, and even changing their purpose for what they do. Each bit of growth at each step feeds the next bit of growth in a continuous cycle. As long as the cycle continues, probably with the support of a personal learning network, growth and change are inevitable.

Another powerful idea about capacity building is that it doesn't depend on what is possible. We have heard from many teachers that they love ideas that we present, but they are simply not possible in their current school because of testing requirements, technology limitations, unsupportive administration, etc. All of those constraints are important for current practice, but none of them matter for capacity building. A teacher might explore ways that learning can be different through small incremental changes at each step always building capacity to take advantage of next year when the school has a new principal, a grant provides additional technology, Race to the Top is

replaced by something else, etc. Most teachers we see have too many constraints to ever reach a true level of Redefinition, but, now, they all have the ability to build capacity toward that even if they feel stuck at Modification.

Conclusion

The PATER Model is not a rejection of TPACK, SAMR, ACOT, trudacot, TIM, or Bloom's Taxonomy. Instead, it is a ladder or spiral staircase to help teachers to think in terms of how these models can help them constantly improve and constantly question their practice and the purpose of their practice. The PATER Model asks the teacher to reflect on practice and use the other models as a guide to build capacity and question the purpose of what they do as they strive to move up the staircase.

References

Arizona K12 Center. (2012). TIM: Arizona Technology Integration Matrix. Retrieved, October 23, 2014, from http://www.azk12.org/tim/

Buzbee, L. (2014, October 15). The simple genius of the blackboard: Why the board-centered classroom is still the best place to teach and learn. In *Slate*. Retrieved, October 23, 2014, from http://www.slate.com/articles/life/education/2014/10/a_history_of_the_blackboard_how_the_blackboard_became_an_effective_and_ubiquitous.single.html

Carrington, A. (2013). The Padagogy wheel v3.0. Retrieved, October 23, 2014, from http://www.unity.net.au/padwheel/padwheelposterV3.pdf

Florida Center for Instructional Technology (n.d.). The technology integration matrix. Retrieved, October 23, 2014, from http://fcit.usf.edu/matrix/index.php

Fullan, M. (with Stiegelbauer, S.). (1991). *The new meaning of educational change.* New York: Teachers College Press.

Green, L.S. (2014). Examining technology integration in school librarianship. *Knowledge Quest 43*(1), 36-43.

Harris, J., & Hofer, M. (2009). Instructional planning activity types as vehicles for curriculum-based TPACK development. In C. D. Maddux, (Ed.). *Research highlights in technology and teacher education 2009* (pp. 99-108). Chesapeake, VA: Society for Information Technology in Teacher Education (SITE).

Jonassen, D.H. (2000). *Computers as Mindtools for Schools: Engaging Critical Thinking, 2nd Ed.* Upper Saddle River, NJ: Merill.

Leonard, L. (n.d.). Bloom's Taxonomy pyramid. Retrieved, December 11, 2014, from http://www.res.rcs.k12.tn.us/teachers/leonardl/blooms_pyramid.html

McLeod, S. & Graber, J. Toward better technology integration: Introducing trudacot. Retrieved, October 23, 2014, from http://dangerouslyirrelevant.org/2014/08/toward-better-technology-integration-introducing-trudacot.html

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

Puentedura, R. (2014). Reuben Puentedura's Weblog. Retrieved, October 23, 2014, from http://www.hippasus.com/rrpweblog/

Sandholtz, J.H., Ringstaff, C., & Dwyer, D.C. (1997). *Teaching with technology: Creating student-centered classrooms*. New York: Techers College Press.

Schön, D.A. (1983). *The reflective practioner: How professionals think in action.* New York: Basic Books.

Wardlaw, L. (2014, January 30). New tools to get the most from your educational technology. *Pearson: Research & Innovation Network*. Retrieved, October 23, 2014, from http://researchnetwork.pearson.com/elearning/new_tools_to_get_the_most_from_your_educational_technology