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Contextualizing TPACK within systems and cultures of practice

Punya Mishra *, Melissa Warr

Arizona State University, USA

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In literature and in life we ultimately pursue, not conclusions, but beginnings.

—Sam Tanenhaus

The COVID19 pandemic brought home the importance of technology in teaching and learning. Globally, around early March 2020, over 84% of the world student population (approximately 1.5 billion learners) were out of school, and educational institutions had no choice but to move online (UNESCO, 2020, timeline of global school closures). This shift was not without its challenges; it highlighted issues of equity and access of technology in our society. But as importantly, it demonstrated that teaching mediated by technology is not the same as just moving the content or processes onto the web. Teaching with technology is complicated. In order to take advantage of new technologies, teachers must often work outside of their comfort zones, which could be due to a range of factors, including but not limited to their lack of knowledge of the tool, their confidence knowing how to best integrate it within their existing lesson plans, and so on. It may also require a shift in their established practices, since the use of technology may not best fit their current pedagogical practices.

Given the range of tools available, as well as the pace at which technology evolves, successfully teaching with technology requires more than technological knowledge. What is needed, as the authors of this special issue document through their research, is less focus on the tool and more attention to the kinds of knowledge, skills, and attitudes (KSA) teachers need to successfully integrate technology in their teaching.

With *Technological Pedagogical Content Knowledge* (TPACKMishra & Koehler, 2006) as a conceptual structure, this special issue addressed three concepts related to teachers' technology-related KSA: the impact of teachers' KSA, assessing KSA, and fostering KSA. Importantly, the articles in this issue took an important perspective on the use of technology in teaching and learning. Rather than emphasize specific technological tools, the articles considered KSA such as problem-solving with digital tools (Hämäläinen et al., 2020; this issue; Sailer et al., 2020; this issue), selecting appropriate digital media and content (Gugeemost & Seufert, 2020; this issue), integrating content and pedagogical knowledge with technological knowledge (Schmid et al., 2020; this issue; Guggemos & Seufert, 2020; this issue), competence beliefs (Rubach et al., 2020; this issue), and reasoning skills (Wekerle & Kollar, 2020; this issue; Tondeur & Howard, 2020; this issue). Valtonen et al. (2020, this issue) described KSA as adapting and changing throughout the first years of teachers' careers, and Tondeur and Howard (2020, this issue) presented an adaptive model for pre-service teacher education that adapts to individual needs.

In each of these cases, what is critical to understand is not how teachers use (or do not use) certain technologies, but rather the underlying technology-related KSA. The technologies will change, and knowledge of how teachers use specific technologies provide us with little information for the future. However, understanding KSA—including how KSA change through support and experience—enable our research to move beyond the present and into the future.

Though we laud the use of the TPACK framework to undergird the research presented in this issue, the COVID19 crisis also underscored other dimensions of technology integration in teaching. For instance, the

* Corresponding author.
E-mail addresses: Punya.mishra@asu.edu (P. Mishra), mcwarr@asu.edu (M. Warr).

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great disparities that exist in access to technology across our communities meant that standard practices of technology integration, which were often school based, would not work. Moreover, teachers who may have been proficient in using technology in face to face contexts may not have the knowledge to teach remotely or online. The rush to re-make the classroom through synchronous video meetings is an indication of the paucity of relevant knowledge of online pedagogy. Essentially this indicates that TPACK does not exist in a vacuum. Technology integration occurs within specific systems and cultures of practice. These systems and cultures can often define or constrain the kinds of moves teachers can make in pedagogical space. By emphasizing the important role of context, the TPACK model takes a step in this direction. We, however, suggest that it is important to clarify what we mean by context. We must descend into the complexities of systems and culture.

In our current work (Warr et al, 2019, 2020) we have been looking at the "spaces" within which education (and educational technology) function, and thus, as spaces where we can engage in intentional design to improve the teaching and learning process. Each space highlights an element of what we commonly call "education". Moreover, each space is an area that educators (including teachers, administrators, and researchers) and policy makers can focus on to invoke change. Each is a space *for* design.

The 5 spaces for design in education are artifacts, processes, experiences, systems and culture. See 1Fig. 1 and Table 1.

Teachers primarily work in the realm of artifacts, processes, and experiences. However, they also must be sensitive to and work within systems and culture, and they are often challenged to incorporate new technological artifacts into their classroom. As systems and cultures mutate, and as new technological artifacts exhibit potential for educational application, teachers must adjust their knowledge, practice, and skills accordingly. Thus, in addition to the technology-related KSA highlighted in this issue, we suggest an emphasis on KSA related to a systems view of education. For example, in order for a new technology (an artifact) to work in a classroom, it must fit within the processes and experiences of the students and teachers of that classroom. Furthermore, that same artifact must work within the educational system and culture, and integrating the technology requires some awareness of how these spaces interact.

In our 5 spaces framework, teachers are primarily concerned with designing artifacts, processes, and experiences for learners. However, teachers are dependent on others at varying levels of complexity for the work they do and have to work within the constraints of broader educational systems and cultures. Teachers have limited control over many of these factors such as the school calendar, academic standards, or school and state/national level policies. The knowledge of these broader systemic and cultural factors may be critical for educator success. Consider, for instance, a teacher seeking to try out a new technology to teach and assess scientific understanding. This lesson (and assessment) do not exist in isolation, merely shaped by the teacher's TPACK. They exist within broader systemic and cultural contexts and discourses, which may include (but surely are not limited to) teacher performance evaluation systems, school rankings, current budgetary constraints, state-level policies and standards, and more. A teacher who understands how these systemic factors work can utilize them intelligently to set herself and her students for success. We do not mean that teachers need to become expert administrators or policy makers. Rather, if teachers are cognizant of these issues, sensitive to constraints, and open to possibilities, they can leverage apparent constraints into recipes for success.

The five spaces for design in education provides a tool to think with—a way to consider how different elements interact in education. However, it also emphasizes the importance of intentional change through design. Many of the articles in this issue discuss the need for teachers to develop design competencies to integrate technologies. The five spaces framework adds a new dimension to this design work: it provides a systems perspective on *what* teachers design. Using the example above, teachers often need to redesign the processes and experiences of their classroom to optimize technology use. For example, a

Table 1
Definitions and examples of the five spaces for design in education.

Space	Definition	Examples
Artifacts	Stable objects that can be perceived through the senses	Apps, devices, software, videos
Processes	A procedure or directions that can be used to achieve a goal outside of the context within it was created	Online learning modules, learning material access and submission procedures, learning management system organization, daily work schedule
Experiences	A piece of time with associated sights, sounds, feelings, and thoughts	Online activities (asynchronous and synchronous), synchronous class meetings, virtual field trips
Systems	An organized and purposeful structure of interrelated and interdependent elements	IT systems, school format requirements (required instructional time, standards for in-person and online instruction), student support services, budgets
Culture	A pattern of shared basic assumptions that allows groups to perceive and interpret the world in similar ways, develop and communicate meaning, and transmit values to new group members	Perceptions of technology, schools, and education broadly; parents' beliefs about online learning and how they should support online learning; societal expectations of the role of schools (including whether online instruction meets these goals)

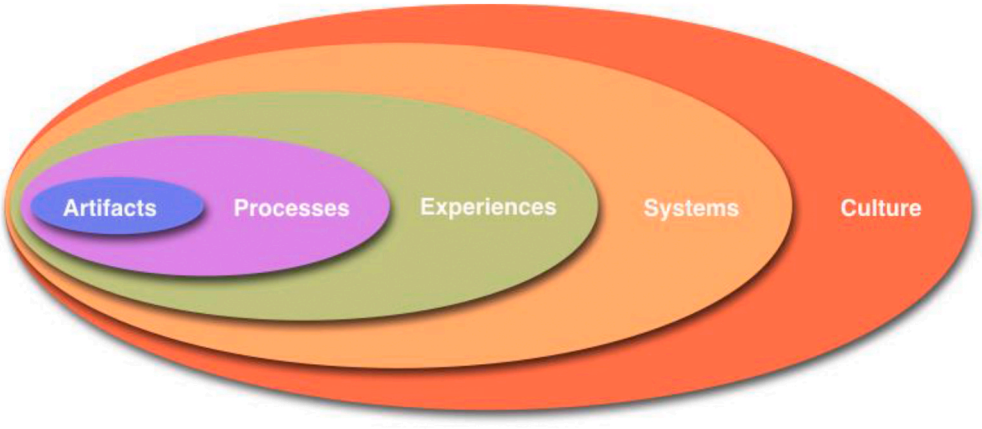

Fig. 1. The five spaces for design in education.

teacher might focus on redesigning classroom procedures (a process) to support new types of devices in the classroom or design a new type of educational experience that capitalizes on the affordances of the technology. KSA for designing processes and experiences within systems and cultures would support fluid teaching practices that optimize the use of new technologies in ever-shifting contexts.

The five spaces framework allows us to also understand processes, systems and culture that may work against the best intentions of educators. It helps us recognize that sometimes the barriers may be outside of the classroom context, and successfully navigating these barriers may require knowledge of systems and culture that are often not discussed in teacher education or professional development programs.

This clearly has applications for research paradigms and agendas. The focus on knowledge, skills, and attitudes in this special issue is of critical importance. This becomes particularly important as we seek to understand, as the articles in this special issue do, the issues from a teacher's perspective. What a broader systemic framework (such as the five spaces for design in education framework) provides is guidance on what kinds of KSA need to be addressed and developed. An understanding of the broader systems and culture within which classrooms operate would allow teachers to acquire aspects of KSA that help them integrate technology in ways that are truly valuable for learners. In other words, as expressed in the quote that began this article, this may be an opportunity for not a conclusion but a new beginning, grounded in a better understanding of the broader context for thinking of teachers and technology and the kinds of knowledge they need to be successful educators.

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