

# Chapter 17

## Context and Teaching with Technology in the Digital Age

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### ABSTRACT

*Context is an essential aspect of educational research. In this chapter, the authors discuss how context has been avoided or has referred to different constructs among educational technology research, especially among research on the Technological Pedagogical Content Knowledge (TPACK) framework. The authors discuss the descriptive, inferential, and practical implications of the framework for the context of teachers' TPACK advanced by Porras-Hernández and Salinas-Amescua (2013). Then, they exemplify the power of this framework by using it to guide a descriptive study conducted to determine the extent to which the publications included context. They also describe what researchers meant by context as understood through the framework for context. The authors found that context was important but often missing from research about TPACK and that the meaning of context has differed widely. They discuss these findings in relation to the TPACK literature as well as for educational technology research.*

### INTRODUCTION

“Context” has had two meanings that make it difficult to discuss without being clear about which is used. Commonly, “context” means things in an environment that are not the focus. This idea is its first meaning with respect to educational research—context is *that which surrounds* the object of study. Context may also refer to the things woven together with the focus in this sense, the things surrounding the object of study

are unable to be separated from it. This idea is its second meaning with respect to educational research—context is that which is *woven together with* the object of study. The former definition suggests context and teachers are independent and capable of being looked at alone, and the latter suggests context and teachers are dependent upon one another and not able to be looked at alone. Each meaning affords and constrains how teaching and learning with technology are conceived, measured, and enhanced.

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Despite the essential nature of context in educational research, there are some signs that educational technology research has avoided context (Garrison, 2003; Kelly, 2010). Among research on the knowledge needed to teach with technology as understood through the Technological Pedagogical Content Knowledge (TPACK) framework (cf. Koehler, Mishra, Kereluik, Shin, & Graham, 2014), context is conspicuously missing (Kelly, 2010; Porras-Hernández & Salinas-Amescua, 2013). Indeed, Kelly (2010) described the “virtual absence of the fourth element of the TPACK model—context—in conceptual analyses and applications of TPACK as well as in research studies” (p. 3887). One effect of not considering teachers’ context is theoretical: There are comparatively few frameworks or theories to guide the consideration of context in educational technology research and development. Another effect is that the field’s understanding of how technology is used in the messiness of classrooms and schools is limited. In addition, educational technology has not made a “contextual turn” like the one that occurred in educational psychology as sociocultural perspectives were integrated into psychology (Cole, 1998; Rogoff, 2003). Finally, educational technology research has lagged in areas in which it could lead, such as how increasingly diverse students are (or are not) provided opportunities to become educated in increasingly diverse learning environments.

Considering this lack of attention to context, there is a need to bring together research about context and research about educational technology. We argue that considering context is essential to understanding teaching with technology in the digital age. We use this chapter first to define context and review the literature on prior research relating to context in different scholarly traditions. Second, we describe a conceptual framework as advanced by Porras-Hernández and Salinas-Amescua (2013) for thinking about context in the TPACK framework. Third, we discuss the value of the framework descriptively, inferentially, and

practically. Fourth, we describe the design, results, and significance of our content analysis on the extent to which context is included in publications about TPACK, as well as what researchers mean by context as guided by the framework for context. Finally, we describe future research directions for TPACK and educational technology.

## **BACKGROUND**

Although educational technology research has rarely included context, educational research broadly defined has a rather extensive history with context. In 1938, Dewey used the word “situation” in a way that aligns with present definitions for “context” and its stated importance. Around the same time, Vygotsky suggested that individuals’ contexts mediate their psychological development. In this section, we review of more recent definitions as a way of introducing key ideas and research approaches relevant to considering context in educational research.

### **Definitions**

Context has taken many different meanings across time and scholarly traditions. In modern usage, the meaning of “context” varies for researchers in different fields. In social psychology, for example, context implies the social environment, meaning the presence of others and their effects on individuals (Ross & Nisbett, 2011). In cultural psychology, on the other hand, context denotes the *cultural* context, the shared values of a group of individuals (Heine, 2011). In other fields, context has a broad meaning that is not specific to a discipline or topic. In such cases, context means the things in the environment around the object of study. Although a consensus about what context means has differed across time and scholarly traditions, scholars know that context has become increasingly important to many social science fields since the 1970s (Burke, 1999). Two perspectives

have been distinguished in a disagreement about whether the word “context” describes conditions around an object of study or conditions that are inseparable from an object of study. The former view, context as *that which surrounds*, assumes context is independent of and external to an object of study—in our case, teachers. The latter view, context as *woven together with*, assumes context to be inseparable from a teacher.

These views have important implications for thinking about and studying teachers and their practice with respect to teaching with technology. From the view of context as that which surrounds teachers, specific aspects of an individual’s context affect their teaching and practice. This view suggests that context can be thought about and measured in analyses as an independent variable. From this view, context may affect teachers, but it is conceptually and analytically separate from them. This recognition also suggests that because context is external and separate from teachers, it is something about which teachers can easily develop their knowledge. From this view, context is conceptually and operationally separate from teachers. Since context is surrounding teachers, then, it can be thought of as something that independently affects how teachers develop the capacity to teach with technology. Accordingly, context can also be thought of as something about which teachers easily develop knowledge, or more specifically *knowledge of context*. Teacher knowledge of context with respect to teaching with technology has been explored through other frameworks in addition to TPACK, such as the Comprehensive Framework for Teacher Knowledge (CFTK; Ronau & Rakes, 2011). Considering context as that which surrounds teachers, as factors that affect teachers, or as something about which teachers easily develop knowledge all represent the view of context as fundamentally separate from teachers. This distinction is important in light of the views of context discussed in the next paragraph, through which context is not separate but rather connected with teachers and their knowledge.

On the contrary, from the view of context as that which surrounds teachers and their knowledge, context must be conceptualized and analyzed together as parts of a complex system. This view of context suggests that teachers and their practice can be understood and measured only in relation to their context. Moreover, this view of context suggests that teachers’ knowledge of their context is less important than the ways in which teachers and their context mutually constitute one another. From the view of context as that which is woven together with teachers, context is conceptually and analytically inseparable from teachers. From this view, context can be thought of as the environment in which teachers’ situated, or context-sensitive, knowledge develops. Thus, an important implication of viewing context as woven together with teachers is studying how teachers develop situated knowledge of technology, pedagogy, content, and their intersections in-context. From this view, then, the relationship between context and teachers’ TPACK is that teachers develop their *knowledge in-context*. Considering context as woven together with teachers and as the site of the development of teachers’ knowledge in-context represent the view of context as inseparable from teachers.

In summary, viewing context as that which surrounds teachers affords analyses of how context independently affects teachers or of how teachers develop knowledge of context. On the contrary, viewing context as that which is woven together with teachers affords analyses of how teachers’ develop their knowledge in-context and as part of a complex system. We develop these ideas further in the next section in order to describe how the conceptual framework for context can apply to analyses of both teachers’ knowledge of context and knowledge in-context and to studies of other aspects of teaching with technology. We do not argue that either view is superior to the other. Rather, “context as that which surrounds” and “context as that which is woven together with” provide researchers with a unique lens through which context is analyzed with respect to teaching with

technology. Moreover, knowledge of context and the development of knowledge in-context provide analytic tools to distinguish between potentially confusing meanings for context. Throughout this chapter, we develop these views of context, both knowledge of and knowledge in, in more detail in order to make clear their potential implications for conceptualizing teachers' knowledge and in order to be careful to not oversimplify the use of these views. These views also have important implications for thinking about and studying TPACK

### **Impact on Educational Research**

A review of prior research reveals that context has affected education research in three main ways: it has shaped the very nature of educational inquiry (Berliner, 2002), informed practice (Berliner, 2006; Bereiter, 2014), and informed the development of theories (Design-based Research Collective, 2003). First, consider how context shapes the very nature of inquiry. In general, teaching and learning are poorly structured domains in comparison to domains such as chemistry and physics. Berliner (2002) contrasts the hard sciences, such as the natural sciences and physics, with the soft sciences, such as the social sciences and educational psychology. Unlike in the natural sciences, according to Berliner:

*Broad theories and ecological generalizations often fail [in educational research] because they cannot incorporate the enormous number or determine the power of the contexts within which human beings find themselves . . . A science that must always be sure the myriad particulars are well-understood is harder to build than a science that can focus on the regularities of nature across contexts. (p. 19)*

Thus, context is important because it is part of the complex, messy domain of education. Attempts to remove the messiness of teaching and learning can be done by studying teaching

and learning through experimental designs that control for the effects of context and contextual variables, but controlling for these variables can limit the extent to which findings are externally (or ecologically) valid.

Second, research conducted in classrooms and schools provides a more direct path for teachers to implement research within their practice compared to research conducted in laboratory settings, or other settings removed from the complexity of classrooms and schools (Berliner, 2006; Bereiter, 2014; Design-based Research Collective, 2003). Traditionally, educational researchers (especially educational psychology researchers) have characterized the relationship between theory and practice as unidirectional: theories should guide practice. Although a more careful analysis reveals that the relationship is not this extreme, the overall tendency in educational psychology scholarship has been to conduct research in ways that minimize the complexity, messiness, and difficulty of obtaining experimental control characteristic of classrooms and schools (Berliner, 2006). This focus on experimental designs has led to sophisticated theories of teaching and learning but sometimes at the expense of understanding how those theories are applied in practice. An alternate pathway embraces the complexity of schools and classrooms as the sites for research. In this pathway, research is directly usable because it was developed and constructed in practice. This research conducted in teaching and learning contexts needs to be synthesized and adapted to best practices to a lesser extent than research conducted in more controlled environments. As a result of research being conducted in-context, findings can be applied to contexts similar to those in which the research was conducted.

Third, attention to context improves theories. Theories of teaching and learning developed without attention to context have not been field-tested across contexts. What works in, for example, supported and well-resourced school districts may not work in the same ways in high-

poverty, urban school districts. An affordance of this context-sensitivity is the potential to not only explain phenomena in more diverse contexts, but also to improve understanding of how findings from diverse contexts can lead researchers to question important existing theories. It was in this spirit that researchers questioned and advanced Piaget's theories of cognitive development from a sociocultural perspective (cf., Cole, 1998; Lave & Wenger, 1991; Rogoff, 2003). These "contextualized theories," those informed by findings from diverse contexts, may prove more externally or ecologically valid (Design-based Research Collective, 2003). In the next section, we discuss the impact of research about context on different scholarly traditions, broadly those most relevant to educational research.

### Impact on Different Scholarly Traditions

Context has had an impact on different scholarly traditions under the broad umbrella of educational research. We highlight its impact upon three fields in particular: educational psychology, the learning sciences, and teacher education. Context in educational psychology research has begun to be more important, as psychology and educational psychology have incorporated sociocultural views of behavior, learning, and development (Alexander, Murphy, & Greene, 2013; Cole, 1998; Göncü & Gauvain, 2013; Rogoff, 2003). Researchers in educational psychology, then, began to study individuals in the contexts—such as their social, cultural, and physical contexts—in which they regularly act. To Anderman and Anderman (2000), a special issue of *Educational Psychologist* marked the beginning of the recent focus in educational psychology upon context—or, recalling Dewey's (1938) and Vygotsky's (1978) references to similar constructs, the renewal of what has been a historical focus. Despite the influence of the sociocultural perspective and the importance of context in educational psychology, the nature and

meaning of context in the field is not always clear (Alexander, Murphy, & Greene, 2011; Anderman & Anderman, 2000; Kagan, 2011; Wieman, 2014).

Context in the learning sciences has been prominent since the field's inception (Brown, 1992; Cobb, Confrey, Lehrer, & Schauble, 2003; Collins, Joseph, & Bielaczyc, 2004). However, as in educational psychology, context's meaning has not always been clear (Design-based Research Collective, 2003; McCandliss, Kalchman, & Bryant, 2003; Tabak, 2004). Context is a central concern in design-based research, a common methodology in learning sciences research, because teaching and learning take place in a complex "ecological" system that is woven together with teachers and learners (Cobb, Confrey, Lehrer, & Schauble, 2003). Context has been and continues to be important in the learning sciences, but important topics for future research remain. Future research needs to move beyond identifying the importance of context to clarifying what context means and describing how and why it affects teachers and students (Lave & Wenger, 1991).

Context has long been a focus in teacher education research. However, the focus has been more on preparing teachers to function in diverse contexts rather than on conceptual or methodological issues related to including context in analyses. The expansion of alternate entryways into teaching has made this debate more salient. Zeichner (2008) described how "one of the most vigorously debated issues throughout the history of formal teacher education has been concerned with the role of various settings on the formation of teachers" (p. 263). An example of the focus on context in teacher education research is Zygmunt-Fillwalk, Malaby, and Clausen's (2010) work in which they placed pre-service teachers in diverse communities for their teaching internships in order to enhance the capacity of teachers to teach in such locations. Helping teachers to understand the contexts in which they teach or will teach is supported through a body of extant research (An and Shin, 2010; Birmingham, Pineda, & Greenwalt, 2013;

Darling-Hammond & Bransford, 2007; Mouza, 2011; Zeichner, 2006). This type of internship placement helps teachers to develop situated—or context-specific—knowledge of the communities, schools, and classrooms, and students, colleagues, and parents with whom they work.

### **Role of Context in Educational Technology**

There is evidence that the field of educational technology has focused on the effects of technology use more than contextual considerations like social interactions, resources, scaffolds, and support for learners (Garrison, 2003; Garrison & Bromley, 2004). Educational technology, broadly defined, is the study of the use of technology in teaching and learning. Educational technology interacts with multiple disciplinary traditions, including educational psychology, the learning sciences, teacher education, and computer science (cf. Spector, Merrill, Elen, & Bishop, 2014). According to Garrison (2003), when context has been included in research, it has been treated as a list of variables, which reflects the view of context as that which surrounds, but is not woven together with teachers. To Garrison and others in related fields (e.g., Cole, 1998; Tabak, 2004, 2013), this idea is an important but incomplete treatment of context. We agree with this interpretation because thinking about context exclusively as a list of variables omits the active role that teachers, students, and the learning environment play in shaping the context of teaching and learning with technology.

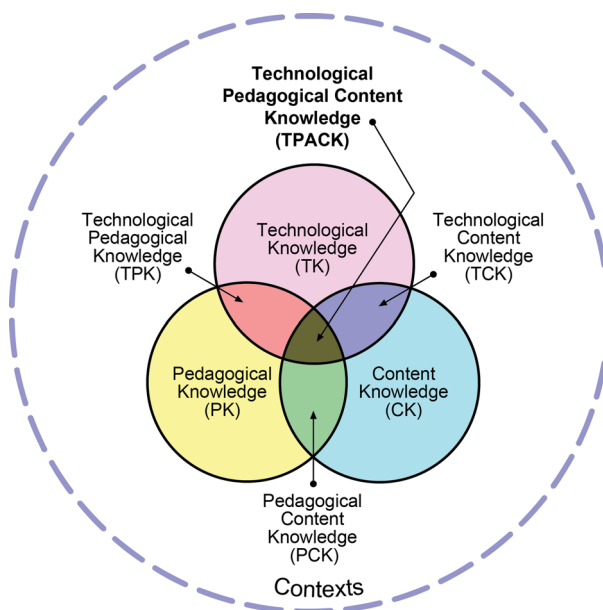
The exception for the purposes of this chapter, however, concerns the TPACK framework. TPACK is noteworthy because of the centrality of context within the framework and the growing prominence of the TPACK framework in research about the role of technology in teacher education and teacher professional development (Brantley-Dias & Ertmer, 2013; Chai, Koh, & Tsai, 2012; Voogt, Fisser, Desimone, Roblin, Tondeur, & van Braak, 2012). In short, the TPACK framework

(Figure 1) suggests that teaching with technology is an act of understanding how knowledge of technology, pedagogy, and content interact with one another as teachers make instructional decisions.

Context has been described as important by the developers of the TPACK framework and is clearly depicted in their diagrams of the framework (Koehler & Mishra, 2008; Koehler, Mishra, Kereluik, Shin, & Graham, 2014; Mishra & Koehler, 2006). As Mishra and Koehler (2006) argue, “technology use in the classroom is context-bound and is, or at least needs to be, dependent on subject matter, grade level, student background, and the kinds of computers and software programs available (p. 1032). Others have also described the importance of context to TPACK. For example, Kelly (2010) characterized context as “one of the most complex, important, and least understood components” (p. 52) of the TPACK framework. Kelly wrote extensively about the nature of context and TPACK in other venues (e.g., 2007, 2008a, 2008b).

In addition to describing the importance of TPACK, others have developed the idea of context further. Angeli and Valanides (2009, 2013) advanced a model for context now referred to as a transformative perspective on TPACK, or a perspective in which it is not possible to distinguish between knowledge of technology, knowledge of pedagogy, and knowledge of content or between learners and context. This transformative view is different from the integrative perspective, wherein it is possible to distinguish between the areas of knowledge and context is represented as separate from the three areas of knowledge. Although Porras-Hernandez and Salinas-Amescua (2013) do not state whether the framework for context that they advance represents either the integrative or transformative perspective, they included actors (teacher and student), which aligns with Angeli and Valanides’ inclusion of learners in their description of the transformative perspective.

Figure 1. The TPACK framework. Reproduced by permission of the publisher, © 2012 by tpack.org.



## A CONCEPTUAL FRAMEWORK FOR CONTEXT IN EDUCATIONAL TECHNOLOGY

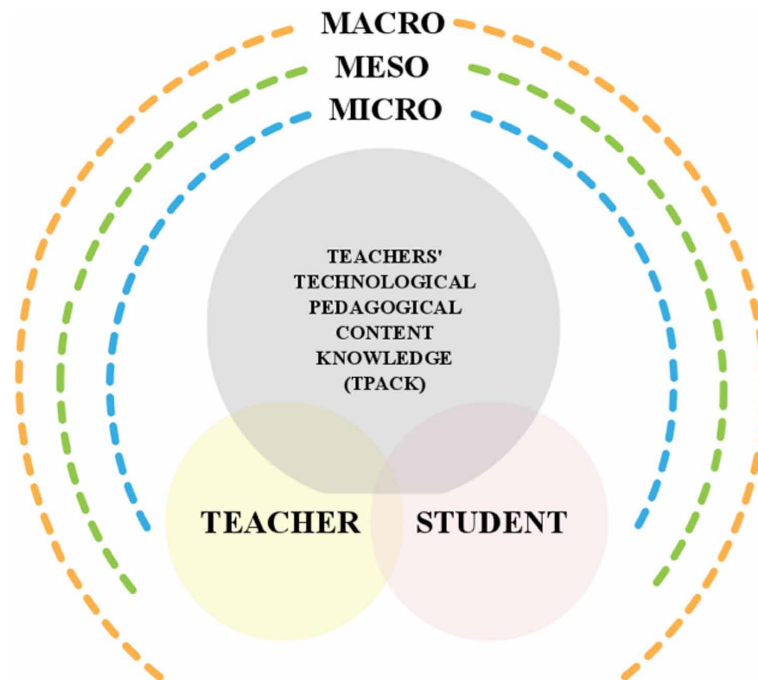
The framework for context advanced by Porras-Hernández and Salinas-Amescua (2013) differs from past attempts to describe the context of teachers' TPACK (e.g., Angeli & Valanides, 2009, 2013; Kelly, 2010; Koehler & Mishra, 2008) by presenting a detailed unpacking of context within the TPACK framework. As a result, this framework for context provides researchers a way to identify and describe the specific ways in which aspects of context interrelate and, more importantly, relate to teachers. We make three contributions to their important work. First, we locate the conceptual framework with respect to the two views of context in TPACK, knowledge of context and knowledge in-context. Second, we compare the framework to ecological theories of development. Third, we identify prior research that illustrates the relation between contextual factors within the five categories in the framework.

Porras-Hernández and Salinas-Amescua's (2013) framework (Figure 2) comprises five categories, including three "levels," micro, meso, and macro, and two actors, teacher and student. In this framework, teachers' TPACK is developed through teachers' interactions in a rich setting of social interactions, scaffolds, and resources as categorized by the three levels and two actors. More specifically, in terms of levels, they described *micro* as classroom conditions, *meso* as school conditions, and *macro* as state and national conditions. In terms of actors, they described *teacher* as involving all teacher characteristics (such as their beliefs, motivations, and other factors) except their TPACK, and *student* as all student characteristics and their beliefs, motivations, and other factors. As noted, this framework is for the context of teachers' TPACK, rather than a framework of teaching with technology or for educational technology use more generally.

Although the framework was originally designed by Porras-Hernández and Salinas-Amescua (2013) to characterize the context of teachers'

*Figure 2. Our Representation of the conceptual framework for context as described by Porras-Hernández and Salinas-Amescua (2013)*

*Note. TPACK develops in the contexts categorized through the three levels (micro, meso, and macro) and two actors (teacher and student). These categories can also be considered areas about which teachers develop knowledge.*



TPACK, we propose this approach as a starting point for thinking more broadly about teaching with technology. To summarize Schwab (1978) through the description of his work by Alexander, Murphy, and Greene's (2011), education is fundamentally an act of "someone teaching something to someone else in some context" (p. 17). Thus, the framework as it is designed then has applications well beyond TPACK. Indeed, the framework may be used to think about a wide scope of educational technology topics and their rich interactions with context. Particularly relevant to this chapter are topics related to teaching with technology in the digital age. That is, one could easily imagine a number of easy substitutions in Figure 1 for the grey circle representing TPACK, including teachers' beliefs about technology use, their creativity, and their pedagogical practice, as well as students' prior knowledge, their problem solving skill, and their engagement in classroom

and disciplinary practices. The characteristics of others involved with teaching with technology, including teachers in informal educational settings, parents, and even peers engaged in teaching one another, could also be substituted for TPACK as the focus of the framework. In short, because the framework can be used to think and talk about context in teaching, it offers a fundamental way to think about wide scope of educational technology topics that involve teachers, students, and their rich interactions with context.

The framework has origins in ecological theories of human learning and development (e.g., Bronfenbrenner, 1981; Bronfenbrenner & Morris, 2006), but there are important differences between the framework and ecological theories. In ecological theories, aspects of context are described with respect to how they reciprocally affect individuals. Thus, although social aspects enter analyses through processes that occur in



the micro level (what Bronfenbrenner and Morris call the microsystem), the focus in ecological theories is always on how *proximal processes*, or interactions among individuals and the people and objects in their immediate environment, affect the developing person. In Porras-Hernández and Salinas Amescua's (2013) framework for context, it is not individuals that are the focus of the analysis, but rather knowledge (TPACK). The key point is that Porras-Hernández and Salinas-Amescua's conceptual framework for context differs from ecological theories in terms of what is being contextualized—an individual, in the case of ecological theories, or teachers' TPACK, in the case of the framework for context.

The framework can be used to explore the two views of context described earlier, knowledge of context and knowledge in-context. In this way, the micro, meso, macro, teacher, and student categories and their relations remain unchanged whether they are considered as factors that independently affect teachers, objects of teachers' knowledge, or categories of factors that affect how teachers' knowledge develops in-context. Therefore, in describing and using the framework for context advanced by Porras-Hernández and Salinas-Amescua (2013) in terms of TPACK research, we argue that both views of context are reflected. Researchers can take the view that teachers are independently affected by factors in the different categories of context or that they develop knowledge of the different categories of context. Researchers can also take the view that teachers' knowledge develops in-context to focus on the ways in which teachers and their TPACK affect and are affected by the contexts in which they teach. In the following sections, we describe each specific category in the framework for context, compare how it is represented to ecological theories, and discuss prior research that illustrates the relation between contextual factors within the five categories in the framework.

## Micro

Micro factors are things in the classroom (or another learning environment), such as available technologies and the layout of the room. Porras-Hernández and Salinas-Amescua (2013) described micro factors as “Concerned with in-class conditions for learning . . . These conditions may involve available resources for learning activities, norms, and policies, as well as the expectations, beliefs, preferences, and goals of teachers and students as they interact (p. 230). Thus, micro is the most proximal context for learning and development. Micro is the conditions in the classroom as well as the interactions among and between people in the classroom and the conditions in the classroom. This part of context is where teachers and students interact and these interactions are critically important to teachers' (and clearly to students') learning and development. Porras-Hernández and Salinas-Amescua's description of the micro category aligns with ecological theories of human development. According to Bronfenbrenner and Morris (2006), upon whose ecological theory of development Porras-Hernández and Salinas-Amescua based their articulation of micro, microsystems are:

*A pattern of activities, social roles, and interpersonal relations experienced by the developing person in a given face-to-face setting with particular physical, social, and symbolic features that invite, permit, or inhibit, engagement in sustained, progressively more complex interaction with, and activity in, the immediate environment. (p. 814)*

Examples of micro characteristics of context in TPACK research include An and Shin's (2010) finding that teachers' “ability to plan and prepare to integrate technology into their curricula and teaching tended to be acted or improved upon with limited technology resources” (p. 105). Another example is Banister and Reinhart's (2011) inves-

tigation of the ways in which teachers' knowledge shapes the classroom contexts in which they function. A final example of micro characteristics is Kelly's (2008) study of digital divides of access to technology, access to technology-enhanced instruction, and access to culturally sensitive technology-enhanced instruction. There are examples of micro characteristics of context in other areas educational technology research: For example, Bell, Maeng, and Binns (2013) worked with pre-service science teachers to integrate technology in order to support science teaching that is aligned with recent reform efforts, such as the Next Generation Science Standards (e.g., NGSS Lead States, 2013). They integrated technology into how pre-service teachers first learned (and later taught in their internships) science content and pedagogical practices and found that "situating" technology into teaching and learning in this way—rather than in a stand-alone educational technology course—facilitated their learning and development.

## **Meso**

Meso factors are things in the school or another setting in which the classroom or learning environment are found. Porras-Hernández and Salinas-Amescua (2013) described meso as "the social, cultural, political, organizational, and economic conditions established in the local community and the educational institution" (p. 229-230). Thus, meso factors are proximal to teachers but are not the contexts where teaching and learning usually take place; instead, meso factors influence teachers through the ways in which the custom and norms of communities and institutions shape teachers' micro context. Bronfenbrenner and Morris described mesosystems as "the linkages and processes taking place between two or more settings containing the developing person (e.g., the relations between home and school, school and workplace, etc.). In other words, a mesosystem is a system of microsystems" (p. 40). Thus, there

is a difference between definitions. To Porras-Hernández and Salinas-Amescua, meso is the next level of context within which micro factors are located, such as a school or neighborhood, whereas to Bronfenbrenner and Morris mesosystems comprise two or more microsystems, so that a mesosystem is characterized as both a classroom and a home. In this chapter, meso as described by Porras-Hernández and Salinas-Amescua as this works to characterize the way micro is nested within meso, despite the conceptual incongruence with Bronfenbrenner and Morris' work.

Prior research by Zygmunt-Fillwalk, Malaby, and Clausen (2010), Cuban, Kirkpatrick, and Peck (2001), and Zhao and Frank (2003) illustrate meso factors' relations with teachers' TPACK. For example, Zygmunt-Fillwalk et al. (2010) focused on how diverse settings at the community level (rather than the classroom level discussed in the previous section) affect teachers' knowledge, although the authors did not specifically focus on the development of TPACK. Specifically, Zygmunt-Fillwalk et al. (2010) sought to involve teachers in diverse communities near their university for their teaching internships. They argued that "teachers in the school represented another perspective and reality, and pre-service teachers were challenged to juxtapose the school and neighborhood cultures for supportive or potentially dichotomous values and practices" (p. 61). From this experience, teachers made connections in their knowledge between the schools in which they were assigned internships, the broader community, and the relation between the school and the community.

## **Macro**

Macro factors are the societal conditions—such as those present among states and regions as well as among national and international institutions—that affect teaching, learning, and other aspects of teachers and students' development. Porras-Hernández and Salinas-Amescua (2013) described macro as "social, political, technological, and

economic conditions. These include the rapid technological developments worldwide, which require constant learning, as well as national and global policies that, in the case of teacher technology integration, become especially relevant” (p. 228). Thus, these factors are the most distal. They are neither at the institution or community level nor at the classroom or learning environment level—but they can still affect teaching with technology in important ways. Bronfenbrenner (1994) described macrosystems as:

*The overarching pattern of micro-, meso-, and exosystems characteristic of a given culture or subculture, with particular reference to the belief systems, bodies of knowledge, material resources, customs, life-styles, opportunity structures, hazards, and life course options that are embedded in each of these broader systems. (p. 40)*

Porras-Hernández and Salinas-Amescua (2013) did not refer to exosystems, another part of Bronfenbrenner and Morris’ ecological model. Bronfenbrenner and Morris (2006) described exosystems as “the linkages and processes taking place between two or more settings, at least one of which does not contain the developing person, but in which events occur that indirectly influence processes within the immediate setting in which the developing person lives (e.g., for a child, the relationship between the home and the parent’s workplace, for a parent, the relation between the school and the neighborhood peer group)” (p. 40). Although it is not necessary to include exosystems, it is worth discussing whether important facets of context are omitted.

The impact of curricular standards such as the *Common Core State Standards* (e.g., National Governors Association, 2010) and the *Next Generation Science Standards* (NGSS; e.g., NGSS Lead States, 2013) upon teachers, administrators, and other stakeholders illustrate some of the ways macro factors can relate to teachers’ TPACK. Zygmunt-Fillwalk et al. (2010) also illustrated

the ways in which macro factors affect teachers’ knowledge and argued that in their “Community and Schools” project discussed in detail in the meso section:

Preservice teachers were challenged to examine the larger, more amorphous structures representing perceptions in the immediate and larger community and society relative to the school and its population of children and families . . . These larger factors, although the least direct in their impact, exert a nonetheless daunting influence on the promise and potential of children and schools. It is not only necessary, but also imperative that preservice teachers consider these issues in relationship to their future work. (p. 62)

Thus, state and national factors can impact teaching and learning in important ways, and there are strategies, such as those illustrated in the “Community and Schools” project, that can help teachers to consider these parts of context.

## Teacher

Teacher factors are all of the characteristics of teachers except their TPACK. Porras-Hernández and Salinas-Amescua described teacher factors as “beliefs, motives, and a teacher’s *raison d’être*” (p. 233). Thus, teacher factors are inside of teachers but shape and are shaped by contextual factors. “Teacher” is not a category in ecological theories, although, of course, the individual who is the focus of analysis is; in other words, a teacher could be considered a category in an ecological theory if he or she were the focus of analysis. Similarly, Ertmer and Ottenbreit-Leftwich (2010) directed attention to the complexity of teaching with technology because of contextual factors related to teachers and argued that “effective teaching requires teacher knowledge change, teacher beliefs change, and teacher culture change” (p. 277). Their solution is in “involving teachers in the visioning process, either through teacher participatory efforts or through teacher education and professional development efforts” (p. 277).

This research identifies the ways in which factors related to the teacher category of context affect teaching and learning with technology.

## **Student**

Student factors are all of the characteristics of students. Porras-Hernández and Salinas-Amescua (2013) described student as “consideration of students’ previous knowledge, attitudes, preconceptions, and interests” (p. 231). Similar to the teacher category, “student” is not a category in ecological theories. Student-related contextual factors can affect teachers’ knowledge (Warschauer & Matuchniak, 2010; Thompson, 2013). For example, Warschauer and Matuchniak (2010) proposed a framework for understanding challenges related to students’ learning with technology based around three areas: access, use, and outcomes. From this framework, scholars can describe challenges of students’ learning with technology and the specific function of teachers in helping students to learn with technology. In addition, Thompson (2013) studied challenges of teaching and learning with “digital natives,” concluding that understanding these students (their knowledge, attitudes, preconceptions, and interests) played a key role in helping them learn with technologies. For example, “teachers can help students develop skills in using a search engine effectively to exploit the full potential of the Web, or help them develop strategies for managing the distractions of technology that is sometimes intrusive on study time” (p. 23).

## **THE VALUE OF A FRAMEWORK FOR CONTEXT**

The framework for context described earlier provides a way to include context systematically and comprehensively in research about teaching with technology, including research about TPACK. In this section, we describe the most specific ways

in which the framework for context described in the previous section is valuable descriptively, inferentially, and in terms of practice.

## **Descriptive Value**

By descriptive value, the value of the framework for context in terms of its capacity is to describe, explain, or help operationalize phenomena related to teaching and learning with technology. The framework helps researchers describe and understand what they and others mean by context. This use of the framework is critical to addressing context in a consistent way, unlike the inconsistency of the “folk definition” criticized by Alexander, Murphy, and Greene (2011). Thus, the descriptive value of the framework for context aligns with our suggestion that the framework for context be used to systematically and comprehensively consider the role of context in scholarship on teaching with technology in the digital age.

Harris and Hofer’s (2014) study provides an example of a descriptive use of the framework for context. They explored how school district administrators such as technology directors conceived and implemented TPACK with the teachers in their district and described their focus as on the meso level of context. They found that contextual similarities and differences helped to explain how districts used TPACK, such as through TPACK-based professional development courses and workshops. The conceptual framework for context allowed Harris and Hofer to describe their work with respect to other contextual factors. The framework also allowed them to focus their work at the school district level in order to advance understanding of an aspect of context that has been the subject of comparatively less research. Harris and Hofer’s work serves as an example of the descriptive value of the framework for context with respect to TPACK. Although this example and the examples for the inferential and practical value of the framework concern TPACK, the application of

the framework in a broader sense suggests that it could be used to study many phenomena related to teaching with technology.

## **Inferential Value**

Inferential value suggests the value of the framework for context in terms of its capacity to assist researchers in knowing where to look and what to look for in terms of teaching with technology. The general categories of micro, meso, macro, teacher, and student are in some ways common across teaching and learning contexts. Because of this understanding, a framework for context helps researchers focus their analysis upon the particular processes or mechanisms involved with teaching with technology. Researchers can also use the framework to draw inferences about what aspects of context have been the subject of comparatively little scholarship.

## **Practical Value**

Practical value describes the value of the framework for context in terms of how to apply research about educational technology to teachers' practice. Researchers can develop interventions, such as technology integration professional development, that acknowledge or leverage contextual factors across the five categories of context. Many researchers already design interventions with teachers' contexts in mind but may focus their attention on factors in some but not all of the categories of context. Important opportunities may remain to more systematically and comprehensively address the context of the teachers (and students) for whom interventions are designed.

Researchers and teacher educators can also use the framework to help teachers think about and enact change in their context. For example, teachers, engaged in the design of technology-integrated lessons as part of coursework or professional development, can use the framework to examine how well their lesson suits the micro, meso, and

macro levels in which they teach as well as how it suits both their own and their students' characteristics. Thus, the framework for context can be used by researchers and teacher educators to promote teacher learning and by teachers as a guide for their lesson planning and instructional design.

Finally, researchers can purposefully conduct studies in unexamined (or under-examined) contexts, such as high-poverty, urban schools, in which technology integration presents exceptional challenges, or informal learning environments such as "makerspaces" (cf. Martinez & Stager, 2013) in which students design, program, and tinker with circuits, textiles, and other creations. In this way, TPACK and educational technology scholars locate their research at the forefront of important problems and opportunities with respect to the diverse settings in which teaching and learning with technology occur and the diversity of teachers and learners in those settings.

## **RESEARCH QUESTIONS**

Previously, Kelly (2010) investigated how prior research about TPACK exhibited various characteristics, such as the data sources and the validity and reliability of the measures used. Kelly also investigated the extent to which prior research included context in analyses and applications of TPACK. Porras-Hernández and Salinas-Amescua (2013) identified that when context was included in analyses, it meant many different things, from teachers' beliefs to classroom and school conditions. To address the widespread meaning for context, they proposed the conceptual framework for the context of teachers' TPACK as described in the previous section of this chapter.

The prior research by Kelly (2010) and Porras-Hernández and Salinas-Amescua (2013) provided an opportunity to advance their work due to three limitations. First, the sample that Kelly (2010) used in his study was small ( $n = 16$ ) and perhaps not representative of all TPACK publications (as

well as of more recent TPACK publications). Second, Kelly did not identify what constituted the inclusion of context in analyses or applications of TPACK. Third, while Porras-Hernández and Salinas-Amescua identified the widespread meaning for context among TPACK research, and proposed a framework for considering context in TPACK research, they did not use the framework to determine what specific aspects of context researchers considered.

To address these needs, we conducted a content analysis of publications about TPACK to provide a comprehensive and accurate view into the extent to which context was included in studies about TPACK, as well as what researchers meant by context by using the framework for context to guide the analysis. While we describe our purpose and research questions, methods, results, and discussion in this chapter, this study is described in greater detail in a journal article (Rosenberg & Koehler, under review). We investigated a greater number of publications ( $n = 16$ ), codified what constituted the inclusion of context, and used the conceptual framework for context advanced by Porras-Hernández and Salinas-Amescua to further analyze the publications that included context to determine what aspects of context (micro, meso, macro, teacher, and student) researchers included. The following two research questions guided our study:

1. Among publications that make use of the TPACK framework, has context been included when authors describe, explain, or operationalize TPACK?
2. For the publications in which context was included, what aspects, as understood through a conceptual framework of context with three levels (micro, meso, and macro) and two actors (teacher and student), are included?

## METHODS

This mixed-methods study used the qualitative coding of data as well as the quantitative counting and analyses of the frequency of the codes. The data were collected from searches of databases (Education Resources Information Center [ERIC] and PsychInfo) as well as of the Mendeley group for TPACK and the TPACK newsletters, in order to obtain the greatest possible number of peer-reviewed publications about TPACK. References for all of the publications found were added to a spreadsheet and then subjected to the following inclusion criteria, which led to 193 publications:

- Published in a peer-reviewed journal
- Published between 2005 and 2013
- About TPACK: Operationally this means that “TPCK,” “TPACK,” or “technological pedagogical content knowledge” are included in the title, abstract (or introduction if an abstract is not included), or keywords
- Empirical in nature
- Published in the English language

Before being analyzed, the data from the 193 publications were segmented by identifying the portion(s) from each publication wherein the authors explained, described, or operationalized TPACK, and entered the segments into a spreadsheet. Thus, only descriptions, explanations, and operationalizations of TPACK were analyzed to determine whether context was included, as well as what researchers meant by context when included. Each segment was then coded to determine whether context was included, and when context was coded as included, what aspects of context were included. Specifically, for a coding frame, we adapted the framework for context as advanced by Porras-Hernández and Salinas-Amescua (2013) as a coding frame, as represented in Table 1.

Table 1. Coding frame for the inclusion and meaning of context

Variable	Description	Codes
Inclusion of Context	The word “context” in descriptions, explanations, or operationalizations of TPACK	1 (included) 0 (not included)
Micro	Factors at the classroom (or learning environment) level in descriptions, explanations, or operationalizations of TPACK	1 (included) 0 (not included)
Meso	Factors at the school (or community level) in descriptions, explanations, or operationalizations of TPACK	1 (included) 0 (not included)
Macro	Factors at the societal level in descriptions, explanations, or operationalizations of TPACK	1 (included) 0 (not included)
Teacher	Factors related to the teacher or teachers in descriptions, explanations, or operationalizations of TPACK	1 (included) 0 (not included)
Student	Factors related to one or more students in descriptions, explanations, or operationalizations of TPACK	1 (included) 0 (not included)

Publications were coded “1” (included) or “0” (not included) for each of the six aspects of the coding frame. For example, if school resources (such as the availability of a computer laboratory) were mentioned in descriptions, explanations, or operationalizations as factors that affected teachers’ TPACK, then “Meso” was coded “1.” Similarly, if teachers’ self-efficacy was mentioned as something that affected the development or assessment of their TPACK, then “Teacher” was coded “1.” Those variables not present in descriptions, explanations, or operationalizations were coded “0.” To establish the reliability of the coding, a second coder analyzed 35% of the publications, we computed the percentage agreement and Cohen’s Kappa statistics for the two coders as presented in Table 2. We interpreted the value of Cohen’s Kappa using guidelines from Sim and Wright (2005), which takes account of chance agreement in its calculation of the percentage agreement between coders.

## RESULTS

We found that only 70 (36%) of publications included context in their descriptions or definitions of TPACK as represented in Figure 3. As an example, in the following text, context is coded as included:

“TPACK is especially referred to as contextualized knowledge that integrates technology and pedagogy on specific content knowledge” (Lin, Tsai, Chai, Lee, 2013, p. 326). Of those 70 articles, most included only descriptions of context related to the micro category (84%). Meso (61%), macro (14%), teacher (57%), and student (44%) factors were less pronounced within this subset of 70 papers. As an example, in the following text, micro is coded as included: “Most studies did not identify the perspectives of teachers or explore how teachers develop TPACK in *real classrooms*.” (Liu, 2013, p. 60-61). As another example, in the following text, student is coded as included: “This context might include students’ prior knowledge and learning difficulties.” (Jang & Tsai, 2013, p. 568). The results for the categories of context included are also represented in Figure 3.

## DISCUSSION

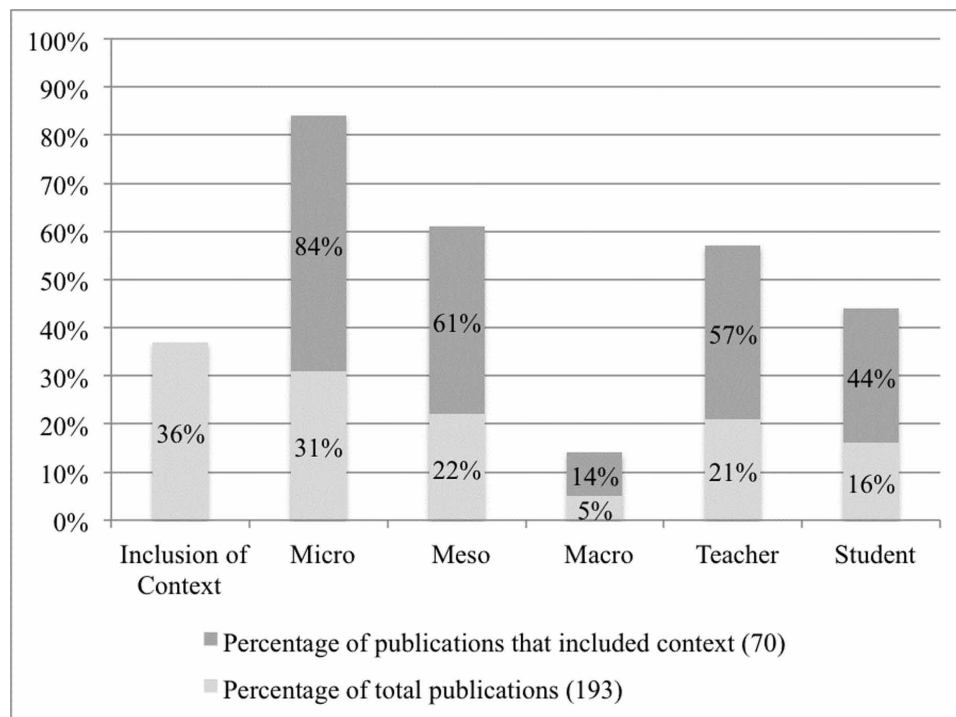
We found that context was included in only 36% of the peer-reviewed publications about TPACK that they studied whereas Kelly (2010) found that context was included in 0% of 16 publications subject to analysis. Thus, these results suggest that context is included to a greater extent than previous work suggested. However, context is not included nearly enough. Due to the importance

*Table 2. Percent agreement and Cohen's kappa statistics*

Variable	Percentage Agreement	Cohen's Kappa
Inclusion of Context	.80	.61 (substantial)
Micro	.83	.47 (moderate)
Meso	.72	.44 (moderate)
Macro	.89	0 (poor)
Student	.83	.64 (substantial)
Teacher	.61	.22 (slight)

*Figure 3. Results for the inclusion and meaning of context*

*Note. Only the 70 (36%) publications that were coded "1" for "Inclusion of Context" were coded for micro, meso, macro, teacher, and student.*



of context in TPACK research as described by its developers and others (Angeli & Valanides, 2009; Harris & Hofer, 2014; Kelly, 2007; 2008a; 2008b; 2010; Koh, Chai, & Tsai, 2014; Porras-Hernández & Salinas-Amescua, 2013), there are opportunities for context to be included more often in studies of TPACK. Greater inclusion of context can help to align TPACK research with the focus on context present in educational research.

Since the results of this study indicated that most descriptions or definitions of context focused on micro factors, these results also suggest that there are opportunities to expand research on context at the meso and macro levels, and with respect to the teacher and student actors. Indeed, macro factors were included in only 14% of the 70 publications that included context. Thus, although we know, for example, that state and national fac-



tors profoundly affect how individuals learn and develop (Bronfenbrenner & Morris, 2006; Ratner, 2011), these factors are rarely being included in analyses of TPACK. We consider this finding an example of an important inference made possible through the use of the framework for context. Although not as pressing as the opportunities to study the effects of factors at the macro level, opportunities to better understand the meso, teacher, and student categories of context call for further research.

An unanticipated finding was that there are many more journal articles about TPACK than we expected based on literature reviews by Chai et al. (2013) and Voogt et al. (2012), who reported 61 and 74 extant publications respectively about TPACK based on comprehensive searches of the literature. The larger number of peer-reviewed journal articles about TPACK reported in our study may be the product of our searches of the TPACK group on Mendeley and the TPACK newsletters in addition to our search of databases. Thus, there may be more publications about TPACK than researchers initially consider, and searching the TPACK group on Mendeley and the TPACK newsletters may enhance the impact of already-published work and advance studies being designed or conducted.

This study has implications for research on teaching with technology and on TPACK specifically. First, this study illustrated how a framework for context can serve as a descriptive lens to researchers: Not only did the framework guide the research questions about how researchers included elements of context, but it also provided a coding framework to guide their analysis. In a similar manner, researchers can use the framework for context in order to address context in their future research. Second, this study provides empirical evidence that context, as researchers have warned (Angeli & Valanides, 2009; Doering, Veletsianos, Scharber, & Miller, 2009) is missing from TPACK research. This reality is important because of the centrality of TPACK to educational technology

research. We discuss additional recommendations that emerged from this study in the section on directions for future research.

## FUTURE RESEARCH DIRECTIONS

We distinguish between future research directions for TPACK and educational technology, although both future directions can be considered part of the same endeavor to enhance teaching and learning with technology. We make two recommendations for future research directions for TPACK. First, the nature of context within TPACK research is an important open question. Knowledge *of* context and knowledge *in-context* provide convenient shorthand to talk and think about two different relationships between TPACK and context, and future research can investigate the ways in which teachers develop either type of knowledge. With respect to their knowledge of context, items could be added to existing measures of teachers' TPACK, such as the TPACK survey (e.g., Schmidt, Baran, Thompson, Mishra, & Koehler, 2009), which does not include teacher's knowledge of context. Including context in measures of TPACK may contribute to a better understanding of the ways in which knowledge of context does (or does not) develop along with teacher development of TPACK. With respect to the development of teachers' knowledge in-context, researchers could use the conceptual framework for context or activity theories as lenses with which to view how teachers and their TPACK interact and change along with the contexts in which they function.

Second, teachers' knowledge of and knowledge in-context may not need to represent an "either/or" scenario, and researchers could study how both teachers' knowledge of context and knowledge in-context develop over time. A possible synthesis that could be studied is that teachers' knowledge of their context is a part of teachers' situated knowledge in-context. In this way, teachers' TPACK is woven together with the contexts

in which it is developed and enacted, and so a subset of each of the domains of knowledge in the TPACK framework is knowledge of how the domain relates to factors at the micro, meso, and macro levels and the teacher and students as actors.

Viewing context as central to educational technology research has important implications for educational technology generally, for which we make three recommendations. First, researchers can pay more attention to the impact of context in other educational technology outcomes. This research may contribute to a better understanding of the specific ways in which contexts affect teachers and teaching with technology. Researchers can use the framework for context to study how various categories in the framework (micro, meso, macro, student, teacher) impact teachers' development and pedagogical practice in their schools and classrooms. For example, researchers could study what specific contextual factors affect teaching with technology in diverse settings, especially those that present particular challenges, including high-poverty urban settings, and those that present particular opportunities, including informal learning environments such as makerspaces. Turner and Meyer (2001) made recommendations for studying context in learning settings that are relevant and helpful to this future research direction: Researchers should investigate more than one variable at a time, involve qualitative and inductive methodologies, describe how and why aspects of context affect teaching and learning with technology, and involve rich interactions between teachers and researchers.

Second, researchers can pay more attention to the ways in which teachers and contexts reciprocally affect each other. This future research direction involves expanding the unit of analysis used in research to include both teachers and their different contexts as described by the framework used in this chapter. Both the categories of context and the object of study would be considered equal in terms of researchers' focus. Thus, researchers would focus on how teachers develop in their

contexts, which also change. By focusing on changes in both teachers and their context, this kind of research would allow a better understanding of how teachers can become agents of change in their classrooms, schools, and communities,

Third, researchers can explicitly include more information about context when they collect data. This additional information about the context of teachers—such as the ability for students to technology at home or in the community, or the availability of high-quality professional development and other resources for teachers—could be treated as independent variables in studies. In this way, researchers would contribute a better understanding of how aspects of context support (or undermine) teaching with technology. In terms of educational technology research in a broader sense, this research can also contribute to a better understanding of how teaching and learning with technology are similar or different across learning environments, so that both may be better supported and enhanced through the design of curricula, resources, scaffolds, and supports.

We consider these future directions for research as starting points for considering the ways in which educational technology research can be enhanced through greater attention to context. Bringing together research about context and educational technology suggests significant opportunities to advance research and practice in critically important areas related to teaching with technology in the digital age. Educational technology researchers are well positioned to address such important areas, and including context more extensively is critical to this endeavor.

Given our call for greater attention to context, we would be remiss to not acknowledge the need for our scholarship to be modified to the different settings—both with respect to research and practice—to which it may be relevant. More broadly, we are sensitive to the ways this work does (or does not) contribute to teachers' practice due to the complexity and particularity of teaching, which is made even more complex through the integration

of technology. In this spirit, then, we encourage the adaptation and appropriation of this scholarship and related scholarship, with the overall aim of enhancing teaching with technology in the digital age in the buzzing, complex contexts in which teachers and students function.

## CONCLUSION

Considering context in educational technology research makes research more messy and complicated, but its benefits are many. First, including context helps educational technology theory to bridge the gap from research to practice in schools and classrooms. Bridging this gap is important because teaching and learning take place not in controlled settings but instead in classrooms and schools that reflect the multiple functions and goals of students, parents, teachers, administrators, and other stakeholders. Context, along with teachers, students, and what is being learned is at the core of education. Second, including context also helps to align educational technology research with other disciplines that honor context and its role. Educational psychology and related fields have demonstrated a renewed, recent focus on including context in analyses. In addition to aligning educational technology research with research in other disciplines, educational technology researchers have an opportunity to lead inquiry in areas that are critically important to teaching and learning in the digital age, including how individuals access, use, and achieve outcomes through technology across their lifespans (Warschauer & Matuchniak, 2010). Third, including context helps to develop better theories that are field-tested across diverse contexts. The benefits of developing theories that are sensitive to context are found not only in their ability to explain more phenomena but also in their ability to question and advance existing theoretical accounts.

Our over-arching goal was to bring together research about context and educational technology in order to consider the role of context in research on teaching with technology. We focused on a conceptual framework for context with three levels, micro, meso, and macro, and two actors, teacher and student. Because there are different interpretations of what context has meant in educational research, we unpacked the implications of viewing context as that which surrounds and that which is woven together with teachers. Viewing context as that which surrounds helps us to study how three levels (micro, meso, macro) and two actors (teacher, student) impact teachers and their practice or how teachers develop knowledge of different contextual factors. Alternatively, viewing context as that which is woven together helps us to study how teachers are situated in the settings in which teachers' knowledge and practice are developed and enacted and how teachers and their context reciprocally develop and change as a complex system.

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## KEY TERMS AND DEFINITIONS

**Context:** The things in the environment that surround and are woven together with an object of study. Context has an extensive history in educational research but has a comparatively limited history in educational technology research.

**Context as That Which Is Woven Together with an Object of Study:** The things that are conceptually and analytically intertwined together with an object of study, in our case a teacher.

**Context as That Which Surrounds an Object of Study:** The things that conceptually and analytically are around an object of study, in our case a teacher.

**Knowledge In-Context:** A view of the relation between teachers' TPACK and their context in which teachers develop knowledge of context in addition to knowledge of technology, pedagogy, and content, and the areas of knowledge that result from considering technology, pedagogy, and content in various combinations. From this view, directing attention to context in research on TPACK is achieved by considering context as an additional area of knowledge.

**Knowledge of Context:** A view of the relation between teachers' TPACK and their context in which teachers develop situated knowledge of technology, pedagogy, and content, and the areas of knowledge that result from considering technology, pedagogy, and content in various combination in-context. From this view, directing attention to context in research on TPACK is achieved by considering how teachers develop *situated*, or context-dependent, knowledge in-context.

**Macro:** Societal factor such as national curricular standards that reciprocally affect teachers and their practice.

**Meso:** School factors such as the resources available to teachers that reciprocally affect teachers and their practice.

**Micro:** Classroom factors such as available technologies that reciprocally affect teachers and their practice.

**Sociocultural Perspective:** A psychological perspective that integrates cognitive, social, and motivational aspects of learning and development into a framework in which individuals learn and develop through participation in social activities. From this perspective, individuals do not learn and develop independently; instead, learning and development are inherently a process that occurs in complex contexts.

**Student:** Student characteristics such as their beliefs, motivations, and other factors that reciprocally affect teachers and their practice.

**Teacher:** Teacher characteristics such as their beliefs, motivations, and other factors that affect teachers and their practice.

**Technological Pedagogical Content Knowledge (TPACK):** The knowledge teachers need to develop in order to be able to integrate technology into teaching. Specifically, teachers need to develop knowledge of technology, pedagogy, and content, and the domains of knowledge comprised from considering technology, pedagogy, and content together.