# Considering the Environment: An Expanded Framework for Teacher Knowledge

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The emergence of active learning classrooms (ALCs) on university campuses introduces a need for university teachers to have knowledge of the pedagogical use of physical space. We consider expanding two well-known frameworks for teacher knowledge. Pedagogical content knowledge (PCK) describes teacher knowledge about teaching discipline-specific content. Technological, pedagogical, and content knowledge (TPACK) recognizes digital technology as part of the knowledge base. With increased attention on learning spaces, we propose redefining technology to include non-digital technologies, (e.g. furniture, whiteboards). Further, we add "environment" to the knowledge base to address rhetorical communications from both the physical space and the classroom climate.

## Introduction

The design and implementation of active learning classrooms (ALCs) is an increasingly common priority for institutions of higher education. While ALCs are currently considered experimental technologies, they are expected to be mainstream by 2022 (Brooks & McCormack, 2019). Teachers and students who have been teaching and learning in traditional classrooms for the better part of their academic careers may soon find themselves in a room with no clear "front" (Park & Choi, 2014) and with contrasting suggestions about what social dynamics and activities should take place there (Lisahunter, Rossi, Tinning, Flanagan, & Macdonald, 2011; Norman, 2010). These physical and accompanying philosophical changes occurring on campuses across the country have been called for by numerous organizations (National Research Council, 2012; New London Group, 1996; Olson & Riordan, 2012). While ALCs certainly have the potential to answer this call, they represent the need for an expanded knowledge base held by teachers at all levels.

Two well-known frameworks for teacher knowledge emerged from research on reforms in education. Shulman's (1987) framework, Pedagogical Content Knowledge (PCK), was developed to describe the knowledge base teachers have as professionals of their discipline (i.e. teaching). More recently, as digital technology became integral to education, Mishra and Koehler (2006) described Technological,

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Pedagogical, and Content Knowledge (TPACK), to describe how teachers' knowledge of these three components overlap when integrating digital technology. These frameworks invited a large body of literature on teaching and learning in both K-12 and higher education settings. However, just as reforms in education inspired the development of these two frameworks, increasing attention to learning spaces requires an expanded framework.

Research on ALCs provides strong evidence that increased student performance in active learning courses taught in ALCs can, in part, be attributed to the physical environment (Brooks, 2011; Cotner, Loper, Walker, & Brooks, 2013; McArthur, 2015; Walker, Brooks, & Baepler, 2011; Whiteside, Brooks, & Walker, 2010). However, instructional strategies that are misaligned with these student-centered spaces can be detrimental to student performance (Brooks, 2012; Lasry, Charles, & Whittaker, 2014). The learning space sets certain expectations for teacher and student behaviors that influence learning outcomes (Gaffney, Gaffney, & Beichner, 2010; Smith, 2017) and the physical attributes of ALCs imply that students will be active participants in learning processes. ALC teachers' awareness of messages sent by the environment and received by students impacts teaching and learning.

We describe a conceptual framework that emerges from literature on learning spaces and the PCK and TPACK frameworks. We build on these two well-known frameworks by introducing a fourth component: environment. PCK and TPACK reasonably highlight the importance of considering how content, pedagogy, and digital technology overlap in teaching practice (Table 1), but recent research indicates that pedagogy and physical space should not be considered independently (Brooks & Solheim,

| Knowledge Domains | | | Short description |
|---|---|---|---|
| Content | Pedagogy | Technology | Teacher's state of knowledge about… |
| X | | | **Content Knowledge (CK)** <br> …concepts, theories, and procedures in their discipline and how knowledge within the discipline is constructed. |
| | X | | **Pedagogical Knowledge (PK)** <br> …broad principles of education including course and lesson design, classroom management, student assessment and evaluation, and the science of learning. |
| X | X | | **Pedagogical Content Knowledge (PCK)** <br> …teaching their discipline. |
| | | X | **Technological Knowledge (TK)*** <br> …transparent (e.g. books and chalkboards) and digital (e.g. computers) technologies and the skills required to use them. |
| | X | X | **Technological Pedagogical Knowledge (TPK)** <br> …using technology to reach pedagogical goals. |
| X | | X | **Technological Content Knowledge (TCK)** <br> …the impact that technology can have on the subject matter. |
| X | X | X | **Technological, Pedagogical, and Content Knowledge (TPACK)** <br> …effective practices of teaching their subject matter with technology. |

*Table 1.* **Summarized definitions of knowledge domains described in Pedagogical Content Knowledge (PCK) (Shulman, 1987) and Technological, Pedagogical, and Content Knowledge (TPACK) (Mishra & Koehler, 2006) frameworks. *Our expanded definition of Technological Knowledge includes transparent technologies.**
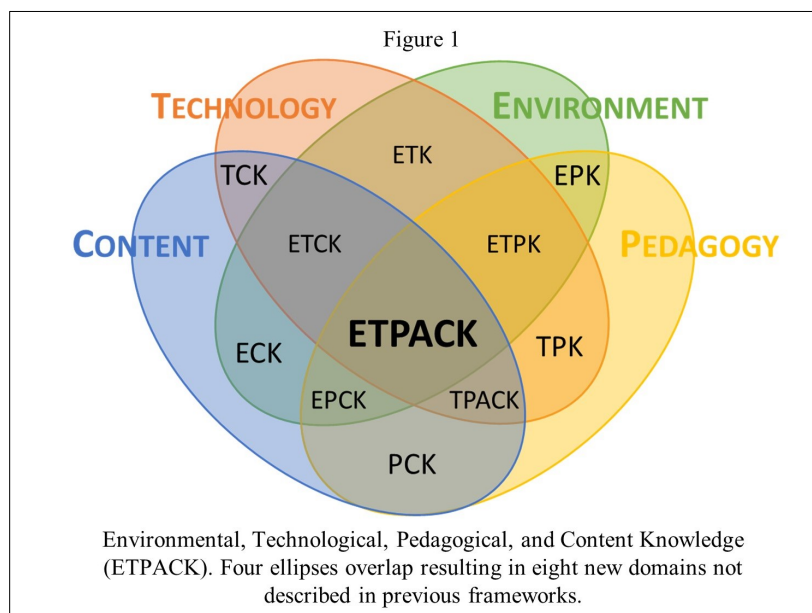
2014; Gaffney et al., 2010; Lasry et al., 2014; McArthur, 2015; McDavid, Parker, Burgess, Robertshaw, & Doan, 2018; Smith, 2017; Walker et al., 2011; Walls, Schopieray, & DeVoss, 2009; Whiteside et al., 2010). Before simply adding physical space to the framework, though, we consider that ALCs themselves are considered a technology. However, TPACK emphasizes primarily digital technology and does not necessarily address the importance of physical space (e.g. furniture arrangement). In the development of this framework, we expand the definition of technology to include non-digital (or transparent) technologies such as furniture, whiteboards, and desks. We add environment in order to separate the physical tools used for instruction (i.e. technology) from the messages conveyed by the learning space and teacher (i.e. environment).

The Environmental, Technological, Pedagogical, and Content Knowledge (ETPACK) framework gives us a lens through which to examine teacher knowledge and practice that takes into consideration the environment in which learning is taking place. It can guide faculty development, observation and evaluation of instructional practices, as well as assessment of student learning. It also invites research that examines how teachers understand and are trained to consider their environment, which instructional strategies and tools best align with the environments in which they are used, and how physical spaces are designed/arranged based on teachers' goals for those spaces.

## An Expanded Framework for Teacher Knowledge

Inclusion of *environment* in a teacher knowledge framework introduces eight new domains that result from overlapping environmental knowledge with technological, pedagogical, and content knowledge as shown in Figure 1. This diagram differs from those used to illustrate PCK and TPACK since it involves relationships between four sets of knowledge. A typical Venn diagram composed of circles cannot represent the fifteen unique domains that arise from ETPACK. Thus, ellipses are used to illustrate the complete ETPACK framework. The following sections briefly describe each new domain and include examples of how each might manifest in a teaching setting. Before presenting these new domains, it is important to remember that, like PCK and TPACK, ETPACK does not describe correct conceptions in each of these domains. Rather, it describes the current state of one's knowledge. Thus, the examples we provide are simply examples of what a teacher might do or know, not necessarily what is considered best practice.

Figure 1

Environmental, Technological, Pedagogical, and Content Knowledge (ETPACK). Four ellipses overlap resulting in eight new domains not described in previous frameworks.

**Environmental Knowledge (EK)** Within any space or part of any gathering of people are (often) unspoken social relationships that shape decorum, language, and even ideologies (Lefebvre, 1991). We propose that the environment of a course encompasses rhetorical messages and social relationships within a learning space. Environment is created in part by a physical or tangible component (discussed in the following section), as well as an intangible environment—a climate—that is established based on recurring behaviors and messages that are sent and received by human actions. Lisahunter et al. (2011) describe spaces as a combination of "other times, spaces, relations, processes, and practices" that are "layered" over time (p. 35). What this means for students and teachers specifically is that their experiences with and knowledge of teacher-student, teacher-teacher, and student-student relationships encourage and suggest that they behave in specific ways and perform specific actions. In a classroom, these recurring behaviors may manifest as students ceasing chatter when a teacher enters or teachers expecting that students will see them as an authority figure because of their education, status, age, gender, etc. Any behaviors that manifest within a space always stem from learned and practiced behaviors in similar spaces.

**Environmental Technological Knowledge (ETK)** Because messages are always sent to individuals from a physical space and its tools, how those messages are received and how they recur shape relationships and identities. According to Walls et al. (2009), "spaces construct the social" (p. 284), meaning that the design, layout, and technologies of a space send messages to its inhabitants regarding who is welcome, and how people should behave

and act within it. In other words, if technological knowledge is understanding what technologies can *do*, then ETK is understanding what technologies (including spaces) *suggest* (Devitt, Bawarshi, & Reiff, 2003). Online classrooms and new media, for example, suggest and facilitate different interactions and behaviors than physical classrooms (Manovich, 2001; Selber, 2004; Selfe, 1999). Whether a digital interface or a physical one, technologies always play a role in determining what social activities and dynamics take shape. Moreover, technologies (i.e., spaces) always establish and reinforce power dynamics (Lefebvre, 1991). In a classroom, the teacher holds power over students and therefore stands at the front of the room facing them. Students sit facing the teacher and support the teacher's power. ALCs, which often decenter spaces and break this dynamic, necessitate a conscious reworking of power dynamics (Lee, Alfano, & Carpenter, 2013). Thus, in a complete framework of teacher knowledge, ETK includes messages sent by the physical space and how those messages affect social relationships that take place within it.

**Environmental Pedagogical Knowledge (EPK)** EPK describes a teacher's consideration of messages received by students from intangible elements within a learning environment and how learning is affected as a result. Intangible elements are defined by the climate created by the teacher and students (Ambrose, Bridges, DiPietro, Lovett, & Norman, 2010). Factors that interact to determine course climate can include the tone set by the teacher, teacher-student and student-student interactions, the range of perspectives represented in the content, what pedagogies are used, and characteristics of students in the course. The instructional decision to implement active learning pedagogies, for instance, conveys certain messages to students. While the intention might be to increase the value of class sessions, students' experience in the course may leave them with the opposite perception (Gaffney et al., 2010). EPK may influence instructional decisions about whether to include a "buy-in" activity before beginning the semester in a new type of classroom, how to word certain policies in the syllabus, or how to manage classroom discussions on sensitive topics.

**Environmental Content Knowledge (ECK)** ECK is knowledge about how the discipline and its practitioners are perceived and how they shape social relationships. As members of their disciplines, teachers in higher education are part of several communities of practice (CoP), that is groups of people who share common practices, behaviors, tools, and jargon, and who maintain ongoing interactions

(Wenger, McDermott, & Snyder, 2002). In addition to the CoP of their specific discipline, teachers may also be part of larger CoPs (e.g. humanities, STEM) that have shared beliefs and values. The behaviors that members of these CoPs exhibit by participating in their unique practices send messages to those on the periphery of the CoP. Students are greatly influenced by these messages and build their professional identities on their observations of, and experiences with their teachers and the professional environment they create (Geschwind & Melin, 2016; Hirschy, Wilson, Liddell, Boyle, & Pasquesi, 2015). The state of a teacher's ECK does not necessarily have direct implications on their teaching but on their interactions in general with anyone outside of the CoP. Indirectly, however, the state of a teacher's ECK shapes how they mentor students and orient them to how members of their discipline exist within and interact with the world and culture around them. In turn, how they communicate topics of their discipline with others will influence how others view members of the CoP.

**Environmental, Pedagogical, and Content Knowledge (EPCK)** As indicated previously, students are influenced by messages sent by a CoP about particular disciplines. EPCK describes a teacher's awareness of that influence and its implications for instruction. Situated cognition considers learning a contextual activity and posits that students learn disciplinary content by engaging in tasks authentic to that discipline (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991). The implication of situated learning theory is that leveraging messages sent by the CoP and discipline itself can facilitate learning of disciplinary content. However, CoPs, disciplines, and certain subject areas can send negative messages that a teacher might not want to leverage, but rather overcome in order to teach content. For example, chemistry students consider physical chemistry difficult because of abstract concepts (Sözbilir, 2004). A teacher's state of EPCK might influence whether they are aware of this perception and how (and if) they choose to address it. Additionally, a teacher's EPCK may influence their decisions about what content to cover, what teaching strategies to use to overcome common misconceptions, and what courses to require of students in certain majors.

**Environmental, Technological, and Content Knowledge (ETCK)** Disciplinary spaces (e.g. writing centers, laboratories, art studios), technologies, clothing, and language used by CoPs are all interpreted and understood by various outside audiences. In other words, CoPs are never solely defined and understood by its members alone but are rather part of a shared interpretation of their role within the community at large. ETCK, therefore, includes concepts, content, and technologies typically used within the discipline, all of which send messages about what is important to practitioners of the discipline. These messages are especially important for students who are in the process of transitioning from a student identity to a disciplinary or professional identity (Berry, 2018). For example, O'Brien & Bates (2015) discuss their study on a CoP called Mentoring Aviators Through Educational Support (MATES), an undergraduate aviation program shaped around building student professional identities. Where many students attend classes wearing clothing such as jeans, t-shirts, etc., and interact with teachers whose profession is teaching, students of MATES attend weekly meetings wearing pilots' uniforms, bring disciplinary tools such as pilots' radios into their classrooms, and interact with current pilots and other professionals in the aviation field. The goals of MATES are to build a CoP among students who can share knowledge and identify their individual gaps of knowledge, create opportunities for students to develop meaningful disciplinary practices, develop a sense of student-professional identity, and connect students to current industry professionals. While these goals are common among teachers in higher education, MATES can achieve these goals by bringing professional elements into learning spaces, and helping students experience professional messages sent and received by industry tools, clothing, and spaces.

**Environmental, Technological, and Pedagogical Knowledge (ETPK)** If EPK focuses on messages sent/received by intangible elements of a learning environment, then ETPK focuses on tangible elements of a learning environment (arrangement of furniture, placement of whiteboards and projectors, existence and location of a podium, movement of the teacher, etc.) and how those elements affect teaching and learning. Tangible elements of the learning environment send messages about what the learning space is intended for (McWilliam, Sweet, & Blythe, 2013; Smith, 2017) and have implications on learning outcomes. Students entering a collaborative learning environment may initially feel they lack authority in the space, especially when considering spaces they are more familiar with, like the lecture hall (Carpenter, 2014). In addition, once their initial expectations have been set by the physical space, deviating from pedagogies that align with it can be detrimental to their course performance (Lasry et al., 2014). A very basic example of how technologies and spaces shape a learning environment is examining the structure of the common lecture hall. According to Park & Choi (2014), the modern lecture classroom has evolved very little since the Medieval period, where students would sit in rows and columns and face a teacher who often possessed the sole copy of the text being studied. Even though there has been a push in higher education for teachers to move from the "sage on the stage" role to the "guide on the side" or even the

"meddler in the middle" (Freeman et al., 2014; McWilliam et al., 2013), many students enter classrooms with desks or tables laid out in rows and columns facing a computer console, podium, and projector screen, and assume that they will take notes at their desks as their teacher lectures. While lecture and note-taking is not the only activity students encounter in this arrangement, it is so common that it is expected. Knowing this, and knowing that learning objectives for a specific class period entail group discussions, a teacher may choose to arrange desks or tables in a circle. This simple change in arrangement signals to students that their attention should be on each other as opposed to a central figure at the front of a room (Smith, 2017).

**Environmental, Technological, Pedagogical, and Content Knowledge (ETPACK)** While the original inspiration to include environment in a teacher knowledge framework was the emergence of ALCs, implications of the ETPACK framework exceed far beyond day-to-day pedagogical and classroom design decisions. ETPACK not only describes teacher knowledge about what messages are sent by physical spaces and tools, but by discipline-specific spaces, tools, behaviors, and practices. It helps teachers think about how those messages will shape student behaviors, relationships, and learning within disciplinary learning spaces. This knowledge will influence how teachers approach course design and teaching in any learning environment and will influence their practice as they help students develop expertise in their fields and transition into professionals. It will also influence SoTL (scholarship of teaching and learning) studies that target how students learn with disciplinary tools and in disciplinary learning spaces. Finally, ETPACK can help make a case for a new generation of learning spaces that specifically target intersections of environment, technology, pedagogy, and content knowledge.
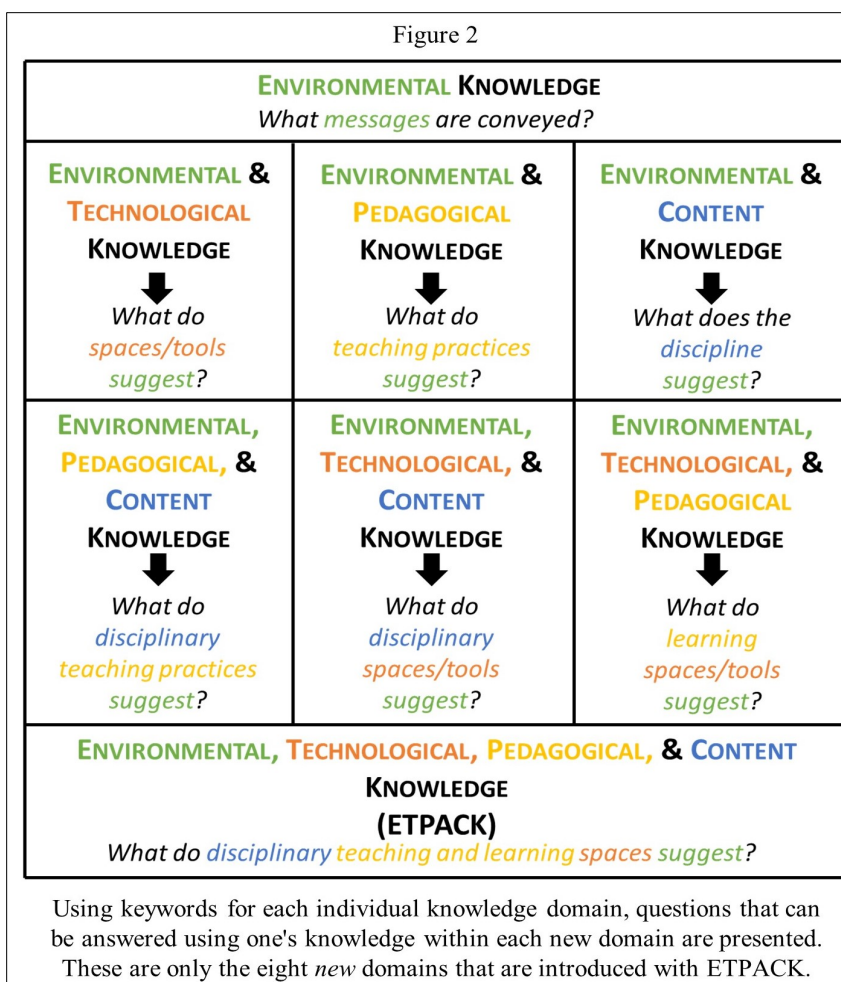
## Concluding Remarks

Existing frameworks for teacher knowledge emerged from changing cultures in education and new approaches to and tools for teaching. PCK provided a way to study how teachers approach course design, lesson planning, assessment, and classroom management among many other teaching practices. When digital technology became integral to education, TPACK provided a means of studying how teachers use technology to meet pedagogical goals. Now,

with ALCs emerging as a "mainstream" technology, we need a way to study how teachers think about using physical and social components of their learning spaces to meet pedagogical goals. ETPACK meets this challenge. As a whole, ETPACK is a framework for teacher knowledge that addresses how disciplinary spaces and tools are used for instruction. However, its component parts have implications for areas overlooked by other frameworks. For example, ETPK describes a teacher's consideration of messages conveyed by learning spaces and tools, a lens through which we can study instructional approaches to teaching in ALCs.

In order to describe ETPACK's eight new knowledge domains, we assigned key words to each individual domain and used these keywords to construct questions that can be answered using one's knowledge within each domain. The keywords are as follows:

- Pedagogy: *learning, teaching*
- Content: *discipline, disciplinary*
- Technology: *spaces, tools*
- Environment: *suggest, messages*

Questions constructed using these keywords are presented for each of the eight domains in Figure 2.



Figure 2

ENVIRONMENTAL KNOWLEDGE
*What messages are conveyed?*

| ENVIRONMENTAL & TECHNOLOGICAL KNOWLEDGE ➔ *What do spaces/tools suggest?* | ENVIRONMENTAL & PEDAGOGICAL KNOWLEDGE ➔ *What do teaching practices suggest?* | ENVIRONMENTAL & CONTENT KNOWLEDGE ➔ *What does the discipline suggest?* |
| --- | --- | --- |
| ENVIRONMENTAL, PEDAGOGICAL, & CONTENT KNOWLEDGE ➔ *What do disciplinary teaching practices suggest?* | ENVIRONMENTAL, TECHNOLOGICAL, & CONTENT KNOWLEDGE ➔ *What do disciplinary spaces/tools suggest?* | ENVIRONMENTAL, TECHNOLOGICAL, & PEDAGOGICAL KNOWLEDGE ➔ *What do learning spaces/tools suggest?* |

ENVIRONMENTAL, TECHNOLOGICAL, PEDAGOGICAL, & CONTENT KNOWLEDGE (ETPACK)
*What do disciplinary teaching and learning spaces suggest?*

Using keywords for each individual knowledge domain, questions that can be answered using one's knowledge within each new domain are presented. These are only the eight *new* domains that are introduced with ETPACK.

The need for professional development for college teachers moving into ALCs has become apparent (McDavid et al., 2018; Stains et al., 2018). Teachers need to be aware of what spaces communicate to students and the implications of those messages on learning. Transparency about the purpose and intended use of spaces and alignment of learning outcomes with the use of physical spaces, content covered, as well as pedagogies and technologies used can help support students in reaching learning goals. Thus, ETPACK functions as a framework for professional development when physical space is the focus. Emphasizing each individual domain (content, pedagogical, technological, environmental) and their overlaps can help teachers make informed decisions when planning to teach in any learning environment.

Research on ALCs, particularly in faculty development, is in its infancy. However, no existing framework adequately guides investigations of how teachers make instructional decisions in ALCs. This is because no existing framework addresses all of the knowledge domains that affect instructional choices including knowledge of classroom-level environment. ETPACK gives researchers a framework for developing research questions and designing approaches to data collection and analysis for investigations of teaching when environment is of specific interest. Following the traditions of PCK and TPACK studies, research on ETPACK investigates the state of teacher knowledge, sources of teacher knowledge, and the development and implementation of teacher knowledge in various learning environments. Alternatively, research using ETPACK describes how teaching approaches, methods, and practices are influenced by the learning environment and vice versa. Finally, ETPACK can guide conversations on learning space design to support the practices of teaching and learning.

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