Developing New Schemas for Online Teaching and Learning: TPACK

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Abstract

Online education has grown dramatically over the past decade, as have the technology applications that support these environments. Although technology applications are an important consideration in online education, a comprehensive view of the online teaching and learning process is needed. The TPACK (Technological, Pedagogical, Content Knowledge) framework explains the complex relationship between content, pedagogy and technology knowledge and how these knowledge domains intersect to create the new kinds of knowledge needed to support online teaching and learning. Understanding TPACK may help instructors develop a new schema for transitioning from face-to-face to online teaching and learning. New schema development allows learners to incorporate new information and experiences into the framework of their pre-existing knowledge. Instructors can become more aware of the complexities of online course development, and they can realize the importance of developing competent consumers (learners). Institutions that provide time for individualized professional development, resources for initial course development, support for ongoing course modification, and systematic evaluation of learning outcomes facilitate the development of online instructors who use technology seamlessly to support content and pedagogy for 21st Century Learners.

Keywords: technological pedagogical content knowledge, TPACK, technocentric, e-learning, faculty professional development, online learning

Introduction

Technology has dramatically changed the look of 21st Century learners as evidenced by the text-messaging, cell phone-talking, iPod listening students strolling on our physical campuses and visiting our virtual colleges and universities. WiFi towers are sprouting up among the brick-and-mortar Ivory Towers, SmartBoards are replacing chalkboards, clickers are replacing raised hands, and syndicated podcasts allow for anytime, anyplace access to lectures. How are these changes impacting learning outside the four walls of the traditional classroom? How are technologies enriching the experience of learning where one in four students is taking online coursework (Allen & Seaman, 2010)? In 2001, Hamilton wrote that "for online education to become mainstream is kind of a depressing thought...it is always second best" (p. 32). Have we made significant changes in the past 10 years to improve this perception? With growing demands from our consumers and our administrators to make more learning available online, are we just trying to "keep up with the Joneses - motivated by the primordial fear of being left behind rather than by a desire to apply sound pedagogical method to the task?" (Weigel, 2002). Here Weigel is referring to the practice by some institutions of just putting coursework online because everyone else is doing it with no regard to the process needed for quality online development.

The Sloan Consortium (Sloan-C) recently released its 7th Annual Sloan Survey on Online Learning (Allen & Seaman, 2010), considered to be "the leading barometer" of online education. Supported by the Alfred P. Sloan Foundation, surveys were sent to administrative leaders at 4,494 higher education institutions. Responses were received from 2,590 institutions for a response rate of 57.7 percent. Survey results indicate that nearly 4.6 million college students were enrolled in one or more online courses in Fall 2008. This 17% increase in online enrollment from the previous year exceeds the 1.2 percent growth of the overall higher education student population. An ongoing project of Sloan-C has been to identify

factors that promote successful online programs at public colleges and universities; faculty beliefs and attitudes are seen as a critical component in building and maintaining quality programs.

Sloan-C also reports the results of faculty surveys in *Online Learning as a Strategic Asset Volume II: The Paradox of Faculty Voices: Views and Experiences with Online Learning* (Seaman, 2009). In that survey faculty report that online instruction requires considerably more time and effort than face-to-face instruction, and they believe that the support and incentives for teaching online are inadequate. On the other hand, faculty are motivated to teach online because they believe that online teaching meets student needs for flexibility and that it is an effective way to reach particular students.

One noteworthy outcome of the survey is that faculty believe that online learning outcomes may be inferior to those for face-to-face instruction. Seaman (2009) cautions that the "survey responses on learning outcomes are based on faculty perceptions as opposed to outcomes-based assessments" (p. 40), and he poses two important questions. "Are the perceptions about an inferior learning environment for online learning false and do such perceptions need to be countered with data? Or are they accurate, and online learning needs to improve its pedagogy?" (p. 40). Interestingly, less than 30% of faculty surveyed said they were motivated to teach online because of the pedagogical advantage.

In this position paper we posit that pedagogy is central to the success of online course development and that the TPACK (Technological, Pedagogical, Content Knowledge) conceptual framework is key in enabling instructors to develop new schema for a re-conceptualization of content, pedagogy and technology. Professional development focused on understanding the dynamic relationship between content, pedagogy, and technology would improve online course development and result in more satisfied learners and more confident instructors. We discuss TPACK as a framework for discussion and knowledge development surrounding online teaching and learning for instructors and for their learners. Changes in learning online are not just *about the technology* but about a much more complex and "wicked problem" that warrants a re-framing of traditional thinking about teaching and learning (Mishra & Koehler, 2006).

Online Pedagogy - The TPACK Framework

Mishra and Koehler developed the TPACK framework in 2006. It is being used extensively in theory and practice to explain the complex relationship between content, pedagogy, and technology knowledge and how this knowledge is used in teaching and learning. Based on Shulman's work (1986) on PCK (pedagogical content knowledge), Mishra and Kohler address the complex, multifaceted and contextual nature of teacher knowledge in their conceptual framework shown in Figure 1.

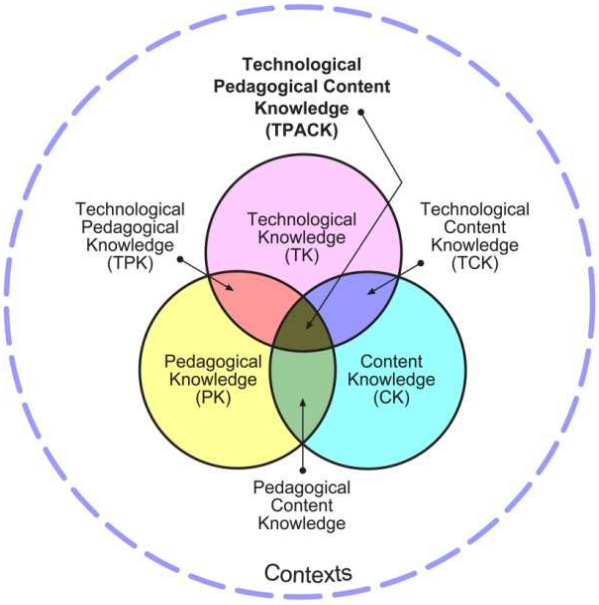

Figure 1. TPACK Conceptual Framework Model (Mishra & Koehler, 2006)

Viewed as discrete domains, instructors are likely to understand the basic tenets of content, pedagogical, and technological knowledge. For example, instructors are well versed in the subject matter they teach

(content knowledge). They consider how their students learn, ways to engage their students in the learning process, and appropriate ways to assess learning (pedagogical knowledge). Instructors use various technological tools and resources in their classrooms (technological knowledge). The TPACK framework, however, suggests that content, pedagogy, and technology play unique and interactive roles in the teaching and learning process.

In their heralded paper *Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge,* Mishra and Koehler (1996) provide an in-depth explanation of the components of the TPACK model. Pedagogical content knowledge (PCK) reflects the ways teachers consider the connections between subject matter and instructional strategies. Learning is promoted when teachers consider how pedagogy can be adapted to meet the unique content and skills of varying subject areas such as science or language arts. Technological content knowledge (TCK) considers the ways in which subject matter and technology are related. Although technology applications may constrain the representation of subject matter, newer technologies may provide opportunities for more varied and effective ways to represent content knowledge. Technological pedagogical knowledge (TPK) addresses the ways in which specific technology tools can promote teaching and learning and how the teaching process itself may change an outcome of using specific tools. Finally, technological pedagogical content knowledge (TPCK) "is an emergent form of knowledge" that is developed beyond content, technology, and pedagogy alone (p.1028).

> Effective technology integration for pedagogy around specific subject matter requires developing sensitivity to the dynamic, transactional relationship between all three components. A teacher capable of negotiating these relationships represents a form of expertise different from, and greater than, the knowledge of a disciplinary expert (say a mathematician or a historian), a technology expert (a computer scientist) and a pedagogical expert (an experienced educator). (Mishra, 2008, para. 2).

There has been considerable attention in the K-12 teacher education research literature related to the "dynamic equilibrium" of the TPACK components and the impact on teaching and learning in online environment (Mishra & Koehler, 2006). For example, the impact of the TPACK framework has been examined within the context of K-6 literacy education (Schmidt & Gurbo, 2008) and with K-12 teachers to address the equity of access to information and communication technology (Kelly, 2008). In addition, a variety of authors speak to TPACK use in content areas such as world language (Olphen, 2008), social studies (Lee, 2002), mathematics, (Grandgenett, 2008), and the arts (DePlatchett, 2008). Inquiry related to the TPACK model has not been evident to this degree in higher education, yet the need to develop quality online learning experiences in higher education is widely accepted. A starting point in considering the viability of TPACK in higher education is to consider whether the TPACK model is useful as a framework in the online higher education classroom.

Developing New Schemas for Online Teaching and Learning

Understanding TPACK may be significant in helping instructors develop new schema when thinking about transitions from face-to-face to online teaching and learning. Piaget (1970) discusses schema, the central building blocks of new knowledge construction. Development of a new schema around online teaching and learning takes place through the interaction of two forces: assimilation and accommodation. Through assimilation learners incorporate new information and experiences into the framework of their prior knowledge constructs in an attempt to make the unfamiliar familiar. Instructors are faced with new ideas about how to teach in online environments that cannot be reconciled with knowledge constructs surrounding their existing content, pedagogy, and technology knowledge. To resolve this dissonance or contradiction, learners need time and a way to bring their knowledge constructs in line with the new information. Accommodation takes place when learners align their new experiences to their existing knowledge. For this accommodation process to occur, new frameworks help learners re-conceptualize their existing knowledge into new schemas over time. Allowing adequate time is an important factor in making these transitions.

Most higher education instructors do not have a history of learning in online environments (Dringus, 2004). For them learning took place at desks in rows, traditional classrooms, and instructor-focused lecture halls. Frameworks for understanding online environments from a learner perspective were not developed. Becoming an online teacher is difficult when you have not experienced this world from a learner perspective. Schema development for online learning needs to bring in perspectives from learner experiences as well as teaching experiences. Assimilation allows new online learner experiences to be combined with pre-existing knowledge about learning to develop new knowledge.

As instructors in higher education begin the transition from their face-to-face classrooms to the online world, much of the focus becomes the technology. Feeling pressure to put content online can sometimes push instructors into practices that simply involve duplication of the face-to-face class into its mirror image online. A lecture becomes a PowerPoint with notes, a class discussion becomes a question posed in a forum, a resource becomes a website in a list of non-descript hyperlinks. The discussion becomes focused on the technology and away from the central issues of pedagogy and content. Most initiatives to move to online coursework begin with "training" of the learning management system (LMS), workshops on podcasting, brown bags on capturing lectures, or discussions on how to transfer PowerPoints online. Technology becomes the central focus of the professional development, if indeed any professional development is offered (Cuellar, 2002). Workshops on the mechanics of using technology: how to set up SmartBoards, using clicker systems, or what buttons to push in specific software are easier to plan that professional development designed to take a deeper look at how to choose certain pedagogies for online engagement or how a content area can be supported by specific types of software or Web 2.0 applications. The professional development is categorized by the technology application, not by the content taught or pedagogy used.

Seymour Papert (1987) identified this process as "technocentric - the fallacy of referring all questions to the technology" (para. 9). Over 20 years ago Papert questioned the impact technology would have on teaching and learning. He was extremely insightful when thinking about seamless technology use. In an experiment with children, Papert had them make skeletons with a computer using the Logo programming language. Initially when asked what they were doing, children would respond "working on the computer" or "logo programming", but six months later when children were asked they responded by discussing the task "making a skeleton" or "writing a story." The computer had become part of the culture. Papert writes:

> If you went up to a poet who was busy writing his poem and asked what he was doing, you would be very surprised if he said, "I am using a pencil." Of course he is using a pencil, but the pencil has become invisible. It's not a separate thing; it's part of his life. It's part of his world. And so, too, the computer. We have only succeeded when it becomes invisible. That doesn't mean you don't think about it. You think about it when you need to, when you want to do something with it. But you're thinking about what you want to do with it; you're thinking about that subject matter. This is part of appropriation, making it yours. It's like yourself. (Papert, 1987, para. 90)

Papert was alluding to the same *schema-type thinking* proposed by Piaget. Without a schema allowing deep thinking about how pedagogical technological knowledge (PTK) can help match pedagogical goals with technology, or how content technological knowledge (CTK) supports understanding of technologies support of specific content types, the process becomes reduced to a simplified discussions of what technology is available and how it could work in an online class. Once instructors engage in schema thinking about technology through the TPACK conceptual framework, the discussion takes on a different tone and purpose. As these new ideas begin to take shape in our thinking, we may consider technology, but we focus on the subject matter (content) and how we will teach (pedagogy). When we talk with instructors about the challenges of online teaching and learning, the conversation can begin with a discussion of the scope of the content, the best way for students to learn that content and then what technologies could support that pedagogy. The process is not linear. Instead, it is dynamic in that once technology is discussed, we circle around and think again about how this pedagogy will work online and if this content will come alive for learners within this environment.

TPACK as a Foundational Framework for Online Teaching and Learning

As we begin to work with instructors either interested or encouraged to move their coursework online, we must re-frame the discussion to focus on the areas of knowledge identified by TPACK. Helping instructors identify strong areas of knowledge will enable effective evaluation of the professional development needed to match strengths and weaknesses. Mishra and Koehler (2006) write,

> For instance, consider faculty members developing online courses for the first time. The relative newness of the online technologies forces these faculty members to deal with all three factors, and the relationships between them, often leading them to ask questions of their pedagogy, something that they may not have done in a long time. (p. 103).

To develop new schema surrounding online teaching and learning, we propose that instructors initially engage in a learning module introducing them to the TPACK concepts and engage in some online coursework as a learner. Thinking that is focused on content and pedagogy combined with the ability to verbalize that knowledge is key to working with instructional designers or as the basis for any technology decisions in online course development. Additionally, an Instructor Survey (appendix 1) developed by Archambault and Crippen (2009) serves as an excellent self-assessment for instructors engaged in new professional development initiatives. The 24-item survey is divided into the TPACK main areas of Pedagogical, Technological, and Content Knowledge, as well as some of the cross-over areas such as Technological Content Knowledge, Pedagogical Content Knowledge and the sweet spot in the middle of the TPACK Venn diagram - Technological Pedagogical Content Knowledge. Responses to the 24 items are on a 5-point Likert-type scale. Evidence of content and response-process validity is provided, and estimates of internal consistency (Chronbach's alpha) reliability for subscales ranged from 0.70 to 0.89. Instructors can complete the survey as a pre- or self-assessment to help them understand the complexity of the task as well as help frame their thinking in the three areas as they begin to identify areas of strength and weakness. It can also serve as a way to plan for personalized professional development.

Let's consider the following scenario about an instructor who is considering moving coursework online and the conversations that may occur as a result of learning about TPACK.

A 20-year veteran instructor has been asked to consider putting a few graduate level courses online to meet the growing demands of working adult learners. Jamie, our instructor, is interested and willing to take on this task but has little background in technology use in the classroom. Jamie does use technology personally (e-mail, Blackberry, web for research) and has used the Internet to find classroom resources and to communicate with students via e-mail. Jamie has been very focused on the course content without much consideration or modification of the pedagogical aspects. Generally, Jamie delivers a weekly lecture, includes some time for classroom group discussion, provides handouts of PowerPoint presentations, gives formative quizzes (but does not use the data to change instruction), and gives final summative exams with essays.

Consider a discussion with Jamie about moving coursework online without a discussion of pedagogy and content. The discussion would include how to record lectures or post PowerPoints online, how to give secure quizzes so students do not cheat, how to post questions for a discussion board, and the best way for students to take online essay based examinations. The results are a very technocentric conversation taking existing activities and moving them directly to a mirror image of the course in an online environment.

Now consider this conversation after Jamie learns about TPACK and takes the self-assessment. Jamie is a little puzzled by the discussion about pedagogy and content and wonders how these constructs have anything to do with just moving to the online class. The self-assessment shows that Jamie's strength is with content knowledge (CK) and that a weakness is pedagogical knowledge (PK). For example, Jamie admits that survey items like "My ability to adjust teaching methodology based on student performance/feedback (PK)", have not been an instructional focus, as Jamie had not considered adjusting lectures based on the learning students exhibited in the quizzes.

Technology knowledge (TK) is adequate based on what Jamie can do personally with computers. Technological content (TCK) such as survey items like "My ability to use technological representations (i.e. multimedia, visual demonstrations, etc.) to demonstrate specific concepts in my content area" and technological pedagogical knowledge (TPK) like "My ability to create an online environment which allows students to build new knowledge and skills" are very low.

Now that Jamie has identified strengths and challenges based on the TPACK self-assessment, specific professional development can take place to ensure that support is provided. During the professional development, Jamie articulates pedagogical goals like "I really would like to use quiz data to inform my instruction" resulting in a technological pedagogical decision to use the online rubrics and competencies tool in the LMS to track student understanding by objectives. Jamie found a way in the LMS to report those data back in a time effective way that led to modifications in next week's lesson and the development of remedial modules for non-mastery students. Jamie also considered that a more visual representation of lecture materials really would enhance student interest and understanding. This resulted in a technological content decision to investigate the availability of already developed multimedia representations of the content to supplement or supplant the existing lecture materials.

These are just two examples of how Jamie's schema has begun to change. Jamie now tends to

think about technology in a way that connects it to content and pedagogy, initiating deeper thinking about all the areas of TPACK.

Moving a course into an online environment can and should enhance the learner's ability to grasp content and construct knowledge due to the affordances technology brings to personalized learning experiences. So how do learners think about the affordances that technology brings to online learning environments? Learner expectations in online courses tend to focus first on the "workability" of the technologies and rarely discuss content or pedagogy when asked about online coursework (Kushner Benson & Ward, 2010). Jamie's developing knowledge of the dynamic intersections of the TPACK model will clearly provide an opportunity to discuss and develop a more thoughtful model of online learning for students. Schema development for online learning is also important for the consumers of this type of learning.

Developing Competent Consumers of Online Learning

Evaluations from learners play a role in the assessment of teaching and learning in higher education. Unfortunately most course evaluations do not reflect the changes in classrooms of the 21st century nor do they address online learning based on new schemas. Evaluations might ask about help desk availability, use of the LMS, or connectivity, but they do not ask if the course content and pedagogy were supported by the appropriate technology. Realistically most current students could not even answer questions like this. Consequently, the discussion becomes *technocentric* and a bad help desk experience could mean a low mark for an online course.

This situation calls for the development of smart and competent consumers of online learning. Syllabi should connect objectives to pedagogy to technology activities that reflect the thoughtful nature in which the document was developed. Using this strategy, learners will begin to understand the processes behind the decisions to use a wiki for the development of a class knowledge base, or the decision to post specific sections of a video aligned to specific course objectives, or the decision to use a synchronous web interface for group discussion on a case study. Verbalizing these connections to students when giving assignments cements the concepts and provides students with important information on "why" we are learning this content using these strategies. High levels of respect develop between learners and instructors in honest exchanges about this process and learners begin to feel comfortable discussing how decisions about pedagogy and technology helped them learn the content. Learners become more empowered to make decisions about their own learning, a goal for the transformative type of learning enabled in online environments.

Recommendations for the Development of Online Learning in Higher Education

Helping instructors develop new ways of thinking about online teaching and learning is essential as online education continues its exponential growth. Most instructors were not students in online environments and have not formed schemas for learning in this manner. Piaget (1970) and Papert (1987) encourage us to allow sufficient time for assimilation and accommodation of these concepts to enable integration into our everyday practices. Quality online education will be realized only when traditional views of content and pedagogy are reconceptualized within new frameworks that include technology. Mishra and Koehler (2006) espouse that the dynamic relationship between pedagogy, content, and technology poses "wicked problems" that are typically underestimated by many involved in the integration of technology into teaching and learning. We suggest that instructors might consider the following actions as they develop online courses.

- **Develop new schemas for online learning by understanding the dynamic TPACK framework.** Understanding the TPACK module through reading, learning modules, and discussion will extend instructors' schema and initiate the process of accommodation. New content, pedagogical, and technological knowledge will align with existing knowledge.

- **Become learners in online environments.** Enroll in an online class as a learner to see what it really feels like! Auditing the class of a colleague can also serve this purpose. Similar to auditing a face-to-face class, many course management systems permit "outsiders" to sit in on a class as an observer. Participating in an online class in this fashion will provide potential and novice online instructors an opportunity to experience and reflect upon the online teaching and learning experience.

- **Begin the process of new online course development by first considering content and pedagogy.** Clearly articulated learning outcomes and effective instructional strategies presuppose the integration of technology. Self-assessment will become important as instructors begin to identify where their knowledge is strong and where they will need additional support. Professional development that focuses on a specific area of need, or working with a support team that includes instructional designers *and* collegial content specialists will be more effective than the generic, "one workshop fits all" professional development experiences.

- **Help students become competent consumers of online environments.** When students understand *how* and *why* technology supports their learning, they will become more metacognitive and self-directed in their learning. An effective starting point can be the course syllabi. Syllabi typically include instructional objectives and instructional strategies. These two components can be aligned with course technology applications to demonstrate the relationship between content, pedagogy, and technology.

Even when instructors are motivated and engaged in developing online courses, they cannot do it in isolation. Institutional support is critical if online education is to reach its full potential. Administrators and instructional technology units will need to provide a systematic and holistic approach to course and program development and management - with a strong emphasis on professional development and instructor support. Professional development that centers on the "how to" of various technology applications reduces the focus of online teaching and learning to a *technocentric* experience. We are not suggesting that technological skills should be dismissed; rather we believe that professional development must focus on how technology applications, new pedagogies, and content knowledge are interwoven. Workshops centered on "technology skills" serve a purpose, but professional learning communities hold greater promise for dialogue among instructors on the topics of online pedagogy and content knowledge.

No doubt, online education will continue to grow and expand. Increasing numbers of students will enroll in online courses, more instructors will explore the viability of moving into online teaching, and colleges and universities will offer more fully online degree programs. Quality online education comes with a price tag - and by this we do not mean the cost of tangibles such as hardware and software. Faculty consistently report that online instruction requires considerably more time and effort than face-to-face instruction indicating that the process of new schema development is a complex and "wicked problem." Institutions that provide time for individualized professional development, resources for initial course development, support for ongoing course modification, and systematic evaluation of learning outcomes develop online instructors who use technology seamlessly to support content and pedagogy for 21st Century Learners.

Development of new schemas surrounding online teaching and learning will change the conversations between Jamie's colleagues and students. When a colleague sees Jamie working intently at the computer and asks, "What are you working on today?", instead of grumbling about "trying to figuring out the new learning management system" or "how to put graphics into a PowerPoint", Jamie will be able to talk about, "the way the new tool for synchronous online discussions will help foster student engagement in the new material I am presenting next week " or "the fact that the new LMS can really support our department initiatives to share common assessments and resources to differentiate for our 21st century learners!" New schema development surrounding TPACK and online learning can initiate transformative conversations about teaching and learning in the 21st century.

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Appendix 1: Instructor Survey

How would you rate your ability to do the following tasks associated with teaching in an online environment? 1) poor, 2) fair, 3) good, 4) very good, 5) excellent

Pedagogical Knowledge

My ability to determine a particular strategy best suited to teach a specific concept.

My ability to use a variety of teaching strategies to relate various concepts to students.

My ability to adjust teaching methodology based on student performance/feedback.

Technological Knowledge

My ability to troubleshoot technical problems associated with hardware (e.g., network connections).

My ability to address various computer issues related to software (e.g., downloading appropriate plug-ins, installing programs).

My ability to assist students with troubleshooting technical problems with their personal computers.

Content Knowledge

My ability to create materials that map to specific standards.

My ability to decide on the scope of concepts taught within in my class.

My ability to plan the sequence of concepts taught within my class.

Technological Content Knowledge

My ability to use technological representations (i.e. multimedia, visual demonstrations, etc.) to demonstrate specific concepts in my content area).

My ability to implement curriculum in an online environment.

My ability to use various courseware programs to deliver instruction (e.g., Blackboard, WebCT, D2L).

Pedagogical Content Knowledge

My ability to distinguish between correct and incorrect problem solving attempts by students.

My ability to anticipate likely student misconceptions within a particular topic.

My ability to comfortably produce lesson plans with an appreciation for the topic.

My ability to assist students in noticing connections between various concepts in a curriculum.

Technological Pedagogical Knowledge

My ability to create an online environment which allows students to build new knowledge and skills.

My ability to implement different methods of teaching online

My ability to moderate online interactivity among students

My ability to encourage online interactivity among students

Technological Pedagogical Content Knowledge

My ability to use online student assessment to modify instruction

My ability to use technology to predict students' skill/understanding of a particular topic

My ability to use technology to create effective representations of content that depart from textbook knowledge

My ability to meet the overall demands of online teaching

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