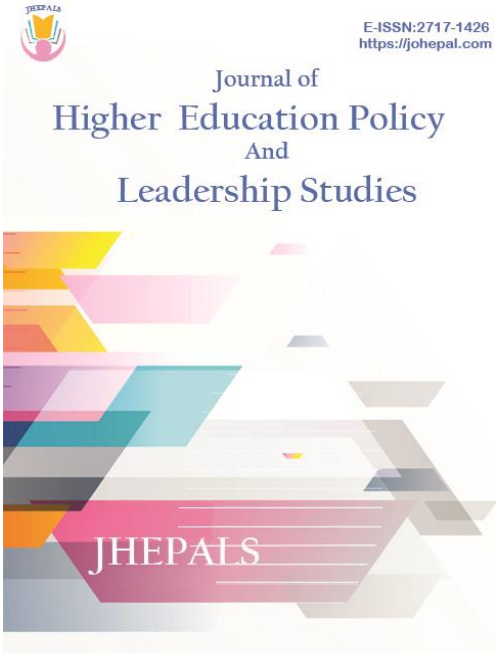
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Developing Instructor TPACK: A Research Review and Narrative Synthesis

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Developing Instructor TPACK: A Research Review and Narrative Synthesis

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Abstract

The number of instructors teaching online in higher education has increased in recent years, and this trend is likely to continue. To be at their most effective at online teaching, instructors need a specialized form of knowledge. This knowledge, theorized as Technological Pedagogical Content Knowledge (TPACK), can help instructors design meaningful learning experiences for students that help them engage and learn. For this reason, administrators and policy makers need information about kinds of educational opportunities and experiences that can help instructors develop their knowledge bases for teaching online and with technology. Researchers have begun to study this phenomenon. In particular, an increasing number of researchers have focused on professional development experiences designed to improve instructor knowledge bases for teaching online. In this narrative research review, we synthesize the results of 13 studies to identify practices related to improved TPACK among university instructors, organizing results by type of intervention. We make recommendations for the ways in which policy makers and administrators can help instructors develop this important knowledge base for teaching.

Keywords: TPACK; Pedagogical Content Knowledge; Higher Education; Faculty Knowledge; College Teaching; Technological Literacy; Faculty Development; Technology Integration

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Introduction

More and more instructors have begun to teach online. In particular, with the advent of the covid-19 pandemic, many instructors found teaching online an imperative. Educators suggest that online learning in institutions of higher education is likely to continue to experience growth in the future (Josep, 2021). Evidence suggests, however, that many instructors who teach online do not feel comfortable with it (Hampton et. al., 2020). In particular, they often do not feel prepared for the change in instructional format (Major, 2010). To be effective at and comfortable with teaching online, instructors need a specialized form of knowledge. This knowledge, theorized as Technological Pedagogical Content Knowledge (TPACK), can help instructors design meaningful learning experiences that promote student engagement and learning. For this reason, it is important for administrators and policy makers to know what kinds of experiences can help instructors develop their knowledge bases for teaching online and with technology in order to best promote and support them.

Researchers have begun to study this phenomenon and have begun to share important information. In particular, an increasing number of researchers have focused on intentional professional development experiences that have the potential to improve their knowledge bases for teaching online. While several research reviews of the TPACK literature have been published in the last ten years (see for example Wang et al., 2019; Nuangchalerm, 2020; Young et al., 2012; Wu, 2013; Yigit, 2014), they tend to focus on pre-service teachers rather than the development of TPACK in instructors in institutions of higher education. Policy makers and administrators need information about how to develop college and university TPACK in order to support them during the growth and development of online learning. The purpose of this article is to provide a review and synthesis of research published in the last ten years that describes interventions that help instructors develop TPACK.

Background

To better understand this review and synthesis, it is necessary to understand two related concepts: pedagogical content knowledge and technological pedagogical content knowledge.

Pedagogical Content Knowledge

Shulman argues that educators have content knowledge (CK), which consists of the concepts, tenets, and theories of their given academic discipline and that instructors also possess a broad pedagogical knowledge (PK), i.e., knowledge about the act of teaching (1986). Shulman also raises the question of why there is a "sharp distinction between content and pedagogical" knowledge? Shulman's contention is that it is insufficient for instructors to have two distinct areas of knowledge, of their given subject and of general instructional techniques. Instead, he suggests the intersection of those two processes is the path to becoming an effective educator. Shulman offers, then, the idea of pedagogical content knowledge (PCK), which is a combination of an instructors' knowledge of their subject matter and of general pedagogy or, as he states, it is "that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of

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professional understanding," (1986, p. 8). He expands upon his definition of pedagogical content knowledge thusly:

> for the most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations—in a word, the ways of representing and formulating the subject that make it comprehensible to others...Pedagogical content knowledge also includes an understanding of what makes the learning of specific topics easy or difficult: the conceptions and preconceptions that students of different ages and backgrounds bring with them to the learning of those most frequently taught topics and lessons. (1987, pp. 9-10).

In sum, pedagogical content knowledge is knowledge unique to educators who must take facets of their subject matter, organize the content, and use pedagogical techniques in order to help students learn most effectively.

For full effect, pedagogical content knowledge necessitates a strong combination of content knowledge and pedagogy. If one area is less developed, teachers may struggle to impart a deep understanding of subject matter to students. And because few higher education instructors receive formal training in pedagogy, their potential for truly effective teaching may be inhibited. Successful teachers recognize that knowledge of content or pedagogy are not separate tools for success but rather are inseparable and necessary components for a unique blend of knowledge.

Technological Pedagogical Content Knowledge

Education technologists Mishra and Koehler build upon Shulman's concepts of pedagogical content knowledge (Shulman, 1986, 1987, 1991) and argue that online educators need technological knowledge in addition to content knowledge and pedagogical knowledge. Furthermore, the overlap and exchange among the three types of knowledge represents significant new forms of knowledge (Mishra & Koehler, 2006; Koehler & Mishra, 2009). Their idea of Technological Pedagogical Content Knowledge (TPACK) is illustrated in the next diagram (from www.tcpk.org; Reproduced by permission of the publisher, © 2012 by tpack.org):

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Faculty TPACK

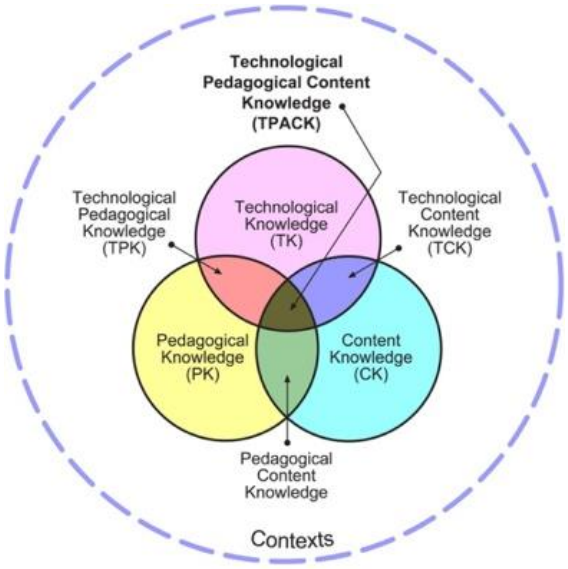


Figure 1. Technological Pedagogical Content Knowledge (TPACK)

At its root, TPACK contends that educators who are teaching online require new expertise and different knowledge compared to their onsite counterparts. TPACK advances beyond its three individual components, integrating and synthesizing their components into new knowledge. Additionally, the TPACK Model offers two new aspects to Shulman's concept of PCK. For instance, technological content knowledge (TCK) is the knowledge of the interaction of technological tool knowledge (TK) and content knowledge (CK). Koehler and Mishra propose that new technologies provide opportunities for educators to represent content in new and different ways in addition to improving student navigability. Thus, they argue that new technology may actually transform the knowledge itself. Furthermore, technological pedagogical knowledge (TPK) is the knowledge of the interaction between technological tool knowledge (TK) and teaching practice knowledge (PK), necessitating that educators have knowledge of multiple technologies and how they work in order to determine which technology best serves their teaching and learning goals.

In sum, educators teaching online require technological knowledge, pedagogical knowledge, and content knowledge, as well as the knowledge created by the overlaps of technology and content, of technology and pedagogy, and of pedagogy and content. If instructors falter in developing any individual area of knowledge as well as they can, then the interactive knowledge is likely to also falter, and teaching and learning may be negatively affected. That may be the most crucial point in understanding TPACK. Simply possessing any of the three individual knowledge areas is not an effective approach to teaching online, teachers must develop the overlapping knowledge. To establish an effective online classroom, instructors understand how technology interacts with content and with pedagogy.

Koehler and Mishra's model is a useful tool to illustrate the type of knowledge teachers need to succeed online. For instance, educators may have a general level of comfort and understanding of social media, understanding how to develop class hashtags, post prompts and collect responses, etc., but if they do not understand the interplay

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between social media and the content of social discussions, then they will be less effective in facilitating online discussions. Furthermore, educators who do not understand how technology interacts with pedagogy (for instance, those who do not consider how to adapt discussion prompts for online consumption and encourage students to respond) will be less successful than those who develop this knowledge. Thus, educators need an integrated and synthesized knowledge of technology, content, and pedagogy.

Methods

We started this review with two overarching questions: how do educators develop TPACK? And what specific actions help educators cultivate TPACK? Though individual examinations of instructor TPACK are paramount, we believed that we could best answer our questions by synthesizing the studies. Synthesis can optimize existing findings, a benefit because of the time-intensive and demanding nature of educational studies (Thorne, 1994). Synthesis also helps build theories in a manner that exceeds individual studies alone (Estabrooks et al., 2005). Also, synthesis offers answers from a wider spectrum of research instead of one individual study, which can be helpful for policymakers, practitioners, and other consumers of research (Gough, 2007). To compile our synthesis, we took the following steps: searching, inclusion and exclusion, article and abstract review, information extraction, data interpretation and analysis, and documentation of results.

Searching

An essential component of research review and synthesis is the use of specific strategies to compile academic research, establishing a clear account of search terms and sources so that research strategies may be recreated. We searched several online databases, including the Educational Resources Information Center (ERIC), Academic Search Elite, and Google Scholar, and we hand-searches tables of content in relevant journals and the bibliographies of pertinent articles.

Inclusion and Exclusion

We maintained consistent decision-making criteria to determine which articles to include in our synthesis based on their content and scope, the timeframe of the studies, their report type, the educational level, the methodology, and the studies' significance to ongoing research.

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Table 1
Inclusion and Exclusion of Studies

Basis of Decision	Action	Rationale
Content and scope	Searched for studies with the descriptor Technological Pedagogical Content Knowledge and TPACK	Descriptors return more complete results than keyword searches.
	Limited timeframe to 2012.	Technology changes rapidly, so older studies might have detracted from meaning.
	Limited the search to research reports and eliminated descriptive reports and opinion papers.	This limitation ensured articles returned were scholarly research.
	Searched within results for descriptors "college faculty" and "higher education."	This limitation ensured a focus on online courses in institutions of higher education and excluded other educational levels, such as adult education, high school equivalency, preschool, k-12.
	Excluded studies in which instructors were not the data sources.	It was critical to learn about instructor experiences directly.
	Excluded studies in which faculty development of TPACK not the focus of the research.	This step eliminated studies of instructor opinions about online learning.
	Searched the contents of key journals in the field of distance education.	Key journals in the field of distance education were most likely to have articles on topic that might have not turned up during a descriptor or key word search. The journals we searched included *American Journal of Distance Education, British Journal of Educational Technology, Distance Education, Educational Technology Research and Development, International Journal of Instructional Media, Internet and Higher Education, Journal of Computing in Higher Education, Journal of Distance Education, Journal of Educational Technology Systems, Journal of Research on Technology in Education, Online Journal of Distance Learning Administration, Open Learning, Quarterly Review of Distance Education.*
	Searched bibliographies of relevant articles returned in our initial searching.	Authors of relevant studies could have cited articles related to specific disciplines that did not turn up in ERIC.

Abstract and Article Review

Once we had completed our search for articles and excluded any duplicates, we reviewed the abstracts of the remaining material to assess whether they were relevant to our key questions. In addition, we scanned each article for their contribution to our analysis and

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removed studies that did not provide any new information. For instance, we excluded articles that duplicated content and reported on the same study. Then, we reviewed each article for scholarly rigor and removed any study that did not meet methodological standards. In analysis of complex literature, determining quality can be a challenge, for instance, there is risk of excluding important articles because of what could be characterized as "surface mistakes" (Dixon-Woods et al., 2006). We did not exclude studies that could be perceived as having minor oversights or methodological omissions. Meeting minimum standards for inclusion does not mean that each article contributed equally to our conclusions, but even "weaker" articles did offer something to our study (as suggested by Dixon-Woods et al., 2006). We also excluded articles when there was a lack of information to assess the study's design, the procedures for data collection or analysis, or whether the author's conclusions were valid. The following table was used to appraise each article's quality.

Table 2
Appraisal prompts for informing judgments about scholarly rigor of studies

Criteria	Prompt Question
Goals	Are the aims and objectives of the research clearly stated?
Design	Is the research design clearly specified and appropriate for the aims and objectives of the research?
Data collection	Do the researchers provide a clear account of the process by which their data were collected and handled?
Data analysis	Is the method of analysis appropriate and adequately explicated?
Trustworthiness	Do the researchers display enough data to support their interpretations and conclusions?
Outlet	Has the paper been published in a peer-reviewed journal or presented at a conference which peer reviews proposals?

Adapted from Dixon et al. (2006)

Information Extraction

From each article, we extracted the following information:
Citation information; Research Purpose; Theoretical Framework; Primary Research Method; Participants; Data Collection Process; Data Analysis Approach; Key Findings/Themes.

Data Analysis and Interpretation

We summarized, synthesized, and integrated the findings from our selected articles. We created an organized list of the themes and findings in order to relate them to each other (Schofield, 1990). For our analysis to synthesize the existing findings, we directly compared and contrasted the narratives of related ideas and themes, determining whether they were unified or divergent (Shkedi, 2005). The included findings necessitated interpretation, but we aimed for consistency with the nature of the original research. We also sought to define and explain existing contradictions among the various studies. In reality, our process for data analysis mirrored those used in primary qualitative research, including the review of papers and identifying transparent, supported, and documented findings in order to develop a critique.

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Documentation of Results

To document our results, we worked to determine the central element of each study that resulted in a change of instructor TPACK. In most studies, this was expressed as an intentional action designed to help educators develop TPACK. Subsequently, we sorted our findings based on the method of intervention (this is presented in greater detail below in the Findings section).

Table 3
Overview of Studies

Author/date	Country	Methodology	Number of institutions	Number of participants
Alsofyani, bin Aris, & Eynon (2013)	Kingdom of Saudi Arabia	Mixed Methods	Multiple (Study conducted out of National Centre for e-Learning and Distance Learning)	21 (Disciplines represented included education, English teaching, computer science, physics, and dentistry)
Brinkley-Etzkorn (2018)	United States	Mixed Methods	1 (Large high-research, land grant institution in the Southeastern United States)	28 (Instructors taught a first-year writing class)
Cherrez and Yi (2020)	United States	Qualitative	1 (Large, Midwest institution)	1 (Instructor taught a freshman compass course)
Faizan, Gottlieb, Löffler, Utesch, & Krcmar (2019)	Germany	Mixed Methods	1 (Technical University in Munich, Germany)	32 (Discipline in business management or information management)
Koh (2019)	Singapore	Mixed Methods	Varied (Graduate course for instructors)	47 (12 higher education instructors)
Koh (2020)	New Zealand	Qualitative	1 (No additional institutional details provided	23 (Disciplines ranging from Health Sciences, Social Sciences, Sciences, and Languages)
Koh et al. (2018)	Indonesia	Mixed Method	Varied (Two-day workshop for Indonesia teachers)	80 (Specific details about faculty not provided)
Muianga, Barbutiu, & Hansson (2019)	Mozambique	Quantitative	1 (Eduardo Mondlane University)	92 (Disciplines ranging from Sciences, Math, Art, Social Science, and Education)
Rienties, Brouwer, & Lygo-Baker (2013)	Netherlands	Quantitative	9 (Research intensive universities)	81 (A range of disciplines represented)
Rienties, Brouwer, Bohle Carbonell, Townsend, Rozendal, van der Loo, Dekker, & Lygo-Baker (2013)	Netherlands	Quantitative	5 (No additional institutional information provided)	67 (No additional discipline information provided)
Simpson &Lindsey (2020)	United States	Qualitative	1 (Midsize, regional institution in the Southeast)	10 (Faculty members in the business discipline)
Sulaimani, Sarhandi, & Buledi (2017)	Saudi Arabia	Quantitative	1 (Female campus of a Saudi Arabian university)	30 (Faculty members in the English as a second language discipline)
Tømte, Enochsson, Buskqvist, & Kårstein (2015)	Norway & Sweden	Mixed Methods	2 (Karlstad University in Sweden and Telemark University College in Norway)	Varied (Case study was on university response)

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Description of Included Studies

We included 13 peer-reviewed, published articles that served as data in our synthesis, descriptions of which are in the table 3.

Findings

Institutions primarily facilitated the development of instructors' TPACK through instructional consultations, train-the-trainer methods, online training courses, scaffolds and long-term distributed training. In total, the evidence indicates that these institutional actions were related to an increase in educator confidence in addition to a change in their teaching techniques.

Instructional Consultations

Two studies we examined in our review examined instructional consultations: Koh (2020) and Cherrez and Yi (2020). In each case, researchers found that the instructional consultations had a positive influence on the development of instructors' TPACK and each case provided specific methods for the successful growth of TPACK.

In an action research study, Koh (2020) examined how individual instructional consultations improved the development of instructor TPACK. This article details the conclusions of a study consisting of qualitative data gathered from 23 members of a teaching staff at a New Zealand university. The participating teachers underwent one-on-one consultations at the university's teaching and learning center in order to improve their technology-enhanced learning. Through a content analysis of the notes provided for 18 consultation sessions, Koh determined that institutions can help instructors create TPACK through consultation, specifically through techniques such as modelling, pedagogical realignment, and encouragement to practice. Koh suggested each of these three methods could be used during an instructional consultation to help instructors meet their differing goals and objectives for technology-enhanced education.

Through a case study, Cherrez and Yi (2020) documented the critical reflective practice of an individual instructor in the context of higher education as it pertains to teaching and learning techniques. Specifically, they outlined methods for witnessing teaching and learning, methods for learning through common experiences, the development of TPACK, and the fostering of professional development. Cherrez and Yi suggested that instructors could cultivate reflective practice in addition to critical reflection through a combination of guided mentoring and collaboration with instructional designers.

Both studies argued that a contextual, individualized approaches to TPACK training leads to an enhanced understanding of the practice. Cherrez and Yi (2020) contended that through smaller mentoring and collaboration settings, faculty members are prompted to reckon with their thoughts and beliefs regarding teaching. Koh (2020) demonstrated how different instructors enter TPACK trainings with different skill levels; therefore, the consultation allowed for the staff member and the instructors to identify specific needs within TPACK for the instructor. According to these researchers, a one-size fits all approach to TPACK training would not be able to provide as in-depth and purposeful training to all instructors as instructional consultations are able to provide.

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Faculty TPACK

Formal Professional Development

Researchers have also assessed the effectiveness of formal professional development offerings, such as instructional workshops, for the development of instructor TPACK. These articles (Koh, Chai, & Natarajan, 2018; Faizan, Gottlieb, Löffler, Utesch, & Krcmar, 2019; Muianga, Barbutiu, & Hansson, 2019) also illustrate the positive influence of institutional action for the growth of TPACK.

In a mixed methods study, Koh, et. al. (2018) assessed the TPACK development of 80 Indonesian teachers as well as their learning outcomes over the course of a two-day workshop. Koh et. al. illustrated how an approach to TPACK development that is supplemented with multi-prong pedagogical reasoning assignments could foster educators' professional development, as well as the implications. Evaluating the quantitative and qualitative effects, Faizan et. al. (2019) examined the TPACK level of thirty-two higher education instructors at the Technical University of Munich in the business college. The participating instructors also underwent train-the-trainer activities to fill in the gaps of their TPACK knowledge. Their research involved survey questionnaires, which were then analyzed through descriptive statistics as well as a tool to measure validation. Muiang et. al. (2019) examined the professional development training program for teachers at Eduardo Mondlane University (UEM). The TPACK model provided the theoretical structure for developing the training and assessing how, or if, the training has changed instructors' pedagogical methods. Their quantitative study analyzed teachers who participated in the training over the course of three years, which involved both in-person and online training sessions. An initial pool of 147 teachers who completed a questionnaire was limited to 92 study participants who had used student-centered learning and instructor-centered teaching for teaching and learning. Muiana, Barbutiu, & Hansson's findings suggest that professional development has an effect on instructors' ideas and behavior and supports the transition from traditional teacher-centered education to student-centered learning.

Educators who participated in the training were more likely to incorporate instructor-centered teaching and student-centered learning because they had changed their opinions of the effect of professional development on their everyday teaching and on the influence it could have on student learning. Also, participating teachers who used student centered learning believed it led to improvements in student learning outcomes and to the overall quality of the educational process.

Within the first two studies pertaining to formal professional development, shared themes emerge between this method of training and the method of instructional consultation. For example, the multi-prong approach described in Koh et. al. (2018) article mirrors attempt to offer different dimensions of TPACK training, as many faculty members come with different skills sets to training. Additionally, Faizen et. al. (2019) echoed similar sentiments from Cherrez and Yi (2020) that emphasize the importance of mentoring and collaboration in train-the-trainer sessions on TPACK.

Within the last study in this section, Muianga et. al. (2019), there were deliberate evaluations of TPACK over the course of three years. With these deliberate evaluations and extended timeline, findings reported a transition from teacher-centered learning to student-centered learning. This last study demonstrated how deliberation and time can have a positive effect on TPACK development.

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Online Training

Throughout the extant literature, online training to improve TPACK was the most commonly examined. Six of the 13 studies we analyzed were examinations of online trainings: Alsofyani, bin Aris, and Eynon (2013), Simpson and Lindsey (2020), Brinkley-Etzkorn (2018), Rienties, Brouwer, and Lygo-Baker (2013), Rienties, Brouwer, Bohle Carbonell, Townsend, Rozendal, van der Loo, Dekker, and Lygo-Baker (2013), Sulaimani, Sarhandi, and Buledi (2017). Of these six studies, just one found that online training did not improve TPACK (Sulaimani et al., 2017); the other five determined that online training had a positive effect on TPACK.

Alsofyani, bin Aris, and Eynon (2013) examined the effects of a brief online training workshop, based on the results of completed questionnaires and observations of 21 faculty members from a variety of disciplines and universities in the Kingdom of Saudi Arabia. They participated in an online training workshop organized by the National Centre for e-Learning and Distance Learning (NCEL) to improve TPACK for educators early in the process of integrating technology into their teaching. The researchers used post-course questionnaires and direct observation to assess the effect of this type of training and found that the training had a positive result. Participating faculty members strongly encourage the combination of expository and active tasks for future online workshops. Taking an active role in their own training is essential for adult learners according to literature examining adult learning and TPACK development workshops. Alsofyani, bin Aris, and Eynon's results affirmed the effect of applying engaging experiences to online faculty development sessions.

A case study conducted by Simpson and Lindsey (2020) analyzed instructor efficacy following participation in a university-specific online professional development workshop which incorporated pedagogical and technological instruction through a TPACK structure. The participating educators were from a business college at a United States mid-size regional university and were taking part in a professional development online. The course was designed to assess instructor efficacy in pedagogical and technological areas and included assignments such as reading comments in the program's Wiki, which had been coded by Simpson & Lindsey. While the participants in the program had some constructive criticism, the broad feedback was positive and suggested that any instructor teaching online should take the course.

For a mixed-methods, quantitatively-driven study, Brinkley-Etzkorn (2018) used three sources of date: (1) teachers' course syllabi from before and after training, (2) student evaluations of teachers from before and after training, and (3) the results of an online survey following the training. The study surveyed 28 instructors across a range of disciplines at one large, land grant university in the United States South. The educators participated in an online training that was intended to improve their knowledge of teaching efficiency and knowledge integration. The study indicated that teachers displayed: (a) statistically significant effects in their integration of training elements when redesigning their course syllabi and (b) overall improvements in their self-reported teaching abilities as surveyed following the training. In aggregate, participating instructors exhibited modest gains in their teaching effectiveness; but the scores of their student evaluations did not change significantly as a result of the training.

Rienties, Brouwer, et. al. (2013) gathered data from 73 academics who participated in an online training program. The participants came from nine higher educational institutions

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and completed a Teacher Beliefs and Intentions questionnaire before and after the program. Among the 33 participants who completed both questionnaires, their TPACK skills improved demonstrably. After a while, the participants were less convinced about the benefits of knowledge transmission and training retention may have been affected by the participants' varying disciplines and institutional cultures, their time investment and their preconceptions about employability.

Rienties, Brouwer, Bohle Carbonell, et. al. (2013) studied an online instructor training program designed and overseen by a team of 14 educators for a program in the Netherlands completed by 67 teachers from a variety of institutions. The study examined data compiled through a pre-test and post-test designed to measure TPACK as well as (perceived) learning satisfaction among the participants to determine the appropriateness of the program's design. The test results demonstrated a substantial increase in most participants' TPACK skills and most of the teachers provided positive feedback about the program itself. However, not all participants were effectively able to learn during the program, suggesting the need for program refinements and additional research.

Sulaimani, et. al. (2017) studied the effect on female teacher's pedagogy of computer-assisted language learning (CALL) at a Saudi Arabian university's in-house professional development training designed on a TPACK-in-action model. The researchers used survey questionnaires completed before and after the workshop as well as semi-structured interviews with participants to determine the influence of the workshop on the educators' pedagogy. The evidence indicated that, although the teachers had sound pedagogy and qualifications, they could not successfully integrate technology into their teaching. Because of institutional policies concerning the integration of technology and a complex pacing guide overseeing learning objectives and educational materials, teachers did not have the flexibility to apply the skills learned from the training in their own classrooms, and thus the training was ineffective. Their study suggests workshops should be designed to suit the needs of teachers who want to integrate technology in their teaching and that it is important to have institutional policies that are informed by training in order for them to be effective.

Throughout these studies pertaining to online training, many trainings offer instructors an opportunity to gain TPACK skills, but perhaps did not offer opportunities to engage with specific pedagogical content, and thus deeper understanding. Studies such as Alsofyani, bin Aris, & Eynon (2013), Brinkley-Etzkorn (2018), Rienties et. al. (2013), Rienties, Brouwer, Bohle Carbonell et. al. (2013), Sulaimani, et. al. (2017) all detailed this similar theme in their findings and recommendations. These findings also harken back to the similar themes of individualized consultations earlier in this review; by addressing the specific needs of the instructors or institutions who are attending the training, participants can engage more with the training content and are more likely to apply skills past training, as well as knowledge integration.

Another emerging theme from this method was the emphasis on respecting faculty members' time and efforts with relation to time spent in training. Simpson and Lindsey (2020) and Rienties, Brouwer, Bohle Carbonell, et. al. (2013) argued that online training sessions can be most effect in the midst of faculty responsibilities. A balance between time, faculty responsibilities, and increasing TPACK understanding is key.

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Formal For-Credit Courses

Two of the studies we included assessed the effect of formal for-credit courses on instructor TPACK: Tømte, Enochsson, Buskqvist, and Kårstein (2015) and Koh (2019). In both studies, researchers observed improved TPACK skills for instructors who participated in the courses.

Tømte, et. al. (2015) examined whether online teacher education programs improved teaching and learning innovation with Information and Communication Technology. Their mixed-method design included quantitative and qualitative measurements and focused on online teacher education programs at two higher education institutions, one Norwegian and one Swedish. They also tracked whether online teachers practiced professional digital competence, both generally and with their subject matters, and if the participants further encouraged student teachers to establish professional digital competence as well. They conclude that, although online teacher education programs can serve as useful tools to encourage student teachers and teachers to establish greater digital competence for the classroom, the programs did not properly integrate that goal. However, there were some interesting takeaways. By examining the beginnings of the ongoing discourse about online education and digital proficiency, the researchers determined that they came from different parties: the discourse on online education began with the management at both institutions, while the conversation about digital proficiency was spearheaded by teaching staff at the two institutions. Their research suggested that there is still a long road toward developing innovative solutions and developing digital proficiency within online teacher education programs.

Koh (2019) studied whether teachers' understandings of pedagogical change could be developed through various TPACK design scaffolds, such as worthwhile learning rubrics, lesson design formulas, and TPACK Activity designs. Koh used pre- and post-course surveys to assess the influence of the design scaffolds on 47 teachers and instructors participating in a graduate educational technology course. Koh also used expert ratings to determine whether the teachers' lesson plans successfully integrated technology before and after completing the course. The results indicated that the design scaffolds improved teachers' TPACK confidence and helped teachers better discuss pedagogical change when designing lessons.

Within the two students pertaining to formal for-credit classes, two very different approaches to TPACK training are outlined. Both studies enhanced an overall confidence toward TPAC with instructors, as these courses provided dedicated time for instructors to improve their skills. Some fine tuning is recommended, especially within the Tømte et. al. (2015) study to ensure that all instructors are benefitting from digital competency. These for-credit courses allow for meaningful and deeper development of TPACK, as seen in the Koh (2019) study, the formal course and subsequent design scaffolds allowed instructor-participants to engage with specific pedological content. This engagement allows instructors to enhance their understanding and increase likelihood of use of skills post-training.

Discussion and Conclusion

Online education demands new ways of knowing as well as new types of knowledge. These demands in turn require new forms of knowledge development beyond what instructors typically undergo to meet the demands of the classroom. Specifically, teaching online

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necessitates learning about technology and how it can transform content and pedagogy. While it is not easy to establish the knowledge required for successful online teaching, doing so benefits the educator as well as improving student learning outcomes. The existing research indicates that instructors value opportunities to improve their knowledge through workshops, courses, and other training, and that continued education and training has a positive effect on their feelings about online technology (see for instance Lee & Busch, 2005; Kotze & Dreyer, 2002; Panda & Mishra, 2007). Other research suggests that as educators' knowledge improves, they're more likely to apply new strategies to their own lessons (see Dempsey, Fisher, Wright, & Anderton, 2008). For instance, teachers with more experience using computers and communication tools are more likely to pursue online teaching (Panda & Mishra, 2007; Walker & Johnson, 2008). Another factor that influences whether teachers will incorporate new technological tools is their own analysis of their comfort level (Parker, 2003). The more time that teachers spend considering the connections between content, pedagogy, and technology and forming integrated TPACK knowledge, the more comfortable they'll become implementing technological solutions in the classroom. But it takes time and effort. Educators can improve their TPACK by studying and training, practicing, working with peers and colleagues, examining the effect on their students, and sharing their own results. There are many different approaches to learn about how to teach online.

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