TPACK Newsletter, Issue #39: February 2019

Welcome to the 39th edition of the (approximately bimonthly) TPACK Newsletter! TPACK work is continuing worldwide. This document contains recent updates to that work that we hope will be interesting and useful to you, our subscribers.

If you are not sure what TPACK is, please surf over to http://www.tpack.org/ to find out more.

Gratuitous Quote About Research

"The true worth of a researcher lies in pursuing what [they] did not seek in [their] experiment as well as what [they] sought."
- Claude Bernard

In This Issue

1. TPACK Newsletter Update

The TPACK Newsletter has been published via the tpack.news email list since January 2009. It has 1244 subscribers currently. Subscription numbers have held steady (+ or – 1% to 3%) since October 2011.

To date, the total numbers of TPCK/TPACK-focused or -supported journal articles, chapters in edited books, books, and dissertations that have appeared in all TPACK Newsletter issues are:

Articles: 995   Chapters: 282   Books: 28   Dissertations: 316

2. Recent TPACK Publications

Below are recent TPACK publications that we know about: 31 articles, 2 books, 39 chapters, and 14 dissertations that have not appeared in past issues of this newsletter. If you know of others that were published within the past several months, please let us know at: tpack.newsletter.editors@wm.edu.

Articles

Adulyasas, L. (2018). Fostering pre-service mathematics teachers' technological pedagogical content knowledge (TPACK) through the learning community. *Journal of Physics: Conference Series*, *1097*, 1–9. https://doi.org/10.1088/1742-6596/1097/1/012094

Abstract: "Technological Pedagogical Content Knowledge (TPACK) is one of the major framework for assessing the knowledge of a teacher in integrating appropriate technology with pedagogy in the teaching content for fostering students' learning. This research aimed to study on pre-service mathematics teachers' level of TPACK after engaging in a learning community during their teaching practicum. The samples were three pre-service mathematics teachers who studied in Mathematics Education Program of Yala Rajabhat University, Thailand selected by purposive technique. Each pre-service mathematics teacher taught the students in different mathematics contents and involved in the learning community which were arranged by the researcher every Wednesday evening or as convenience regularly in order to share and reflect on their teaching. Qualitative data analysis using content analysis was employed to analyze TPACK level of the pre-service mathematics teachers based on TPACK Developmental Model from the data gathered in the focus group discussion during involving in the learning community. The result showed that there are two pre-service mathematics teachers whose TPACK were identified in level 4 (Exploring) and the other one was identified in level 5 (Advancing) which are considered as good level. These finding indicated the successfulness of the learning community in developing pre-service mathematics teachers' TPACK. The relevant suggestions are discussed."

Alabassi, D. (2018). The design and application of a digital storytelling process model to enhance teachers' understanding of TPACK and foster positive attitudes toward teaching with technologies. *International Journal of Technology Enhanced Learning*, *10*(4), 309–328. https://doi.org/10.1504/IJTEL.2018.095142

Abstract: "The study seeks to investigate teachers' perceptions of the process of creating digital stories using a process model (DSPM). The researchers explored how this model fostered effective technology integration skills among teachers as depicted in the technological pedagogical content knowledge (TPACK) framework. A five-point Likert scale questionnaire was used to collect participants' reflections on creating digital stories, their perceptions of how that process affects their TPACK skills, and their views about the pedagogical benefits of using digital stories as a strategy for effective teaching. Eighty-five pre-service and in-service teachers

enrolled in a graduate instructional technology program participated in this study. Generally, the results showed a very strong connection between creating digital stories following the proposed process model and acquiring a positive perception toward technology integration in teachers. The results also revealed a general consensus among teachers on the effective use of digital stories in teaching."

Alizadeh-Jamal, M., Shahvarani, A., Iranmanesh, A., & Tehranian, A. (2018). A study on the changes on teachers' knowledge and beliefs after a workshop based on mathematics education software, by relying on Fuzzy analysis. *PNA*, *13*(1), 19–40. Retrieved from http://digibug.ugr.es/handle/10481/53994?locale-attribute=en

Abstract: "In this paper, the effect of holding a math training workshop using GeoGebra software has been studied on the changes on teachers' knowledge and beliefs. The selected sample is 40 male and female teachers in Iran. Before and after the intervention were administered a pre and post questionnaire with two components: TPACK knowledge and teachers' beliefs. Fuzzy logic and Fuzzy TOPSIS methods were used to analyze the data. The results of this method showed a significant difference between the results before and after the workshop."

Appiah, S. (2018). Religious and moral education (RME) teachers' technological content knowledge base impact on students in junior high schools in Ghana. *International Journal of Multidisciplinary Research and Studies*, *1*(3), 241–257. Retrieved from http://ijmras.com/index.php/IJMRAS/article/view/40

Abstract: "Religious and Moral Education (RME) is an indispensable subject in the Ghanaian educational enterprise. The study was conducted to find out teachers' technological content knowledge in the teaching of Religious and Moral Education (RME) in Aowin municipality in the Western Region of Ghana. The descriptive survey was the design for the study. The population included all (RME) teachers in the Aowin municipality. However, a sample population of 33 RME teachers were used for the study through simple random sampling technique. The data was organized into tables, frequencies, percentages and means in line with the research questions which guided the study. The study revealed that teachers generally had the technological competence in teaching RME but these competencies were mostly manifested in their use of lower levels of technology. Teachers also possessed adequate content knowledge of RME which they appropriately displayed in class. However, the teachers had little knowledge in the Islamic aspect as compared to the other aspects of RME. The study recommended that the Ghana Education Service organize intensive In-service training for teachers on the need to integrate technology in teaching RME. It also recommended that teachers read more on the Islamic aspect of RME in order to have adequate knowledge on it. It was finally recommended that the teacher preparation programme should provide opportunities for potential teachers to learn more skills in integrating technology and content skills in teaching. Consequently, supervisors in basic schools including head teachers, circuit supervisors should strengthen their supervisory roles on what teachers do in the classroom rather than concentrating on what teachers say they can do or are doing."

Aydin, M., & Acik, F. (2018). Investigation of pedagogical content knowledge of Turkish foreign language teacher candidates oriented instructional strategies. *Universal Journal of Educational Research*, *6*(12), 2807–2814. doi:10.13189/ujer.2018.061214

Abstract: "The aim of this study is to determine the pedagogical content knowledge of Turkish teacher candidates for instructional strategies while teaching Turkish as a foreign language. One of the theories that are based on educating prospective teachers in a qualified and equipped manner is pedagogical content knowledge. In this study, the instructional strategies that one of the pedagogical content knowledge components and the pedagogical content knowledge of the teacher candidates were examined and how much they can apply the information, methods, techniques and strategies they have. The sample of this research, which is one of the qualitative research methods, consists of 47 senior class teacher candidates in Amasya University Turkish Language Department. In the study "Teaching Turkish as a Foreign Language Instructional Strategies Knowledge Test" was used as a data collection tool that developed by the researcher. Knowledge test consisting of six open-ended questions for cognitive process steps and the implementation step; a total of six experts, including four field experts and two assessment experts were consulted. The data of the study was carried out by descriptive analysis method to evaluate pedagogical content knowledge. According to the results of the study, it was determined that the teacher candidates have not difficulty in the questions about determining the teaching methods, techniques and student errors. However, they have difficulty in the applications to eliminate student errors."

Bas, G., & Senturk, C. (2018). An evaluation of technological pedagogical content knowledge (TPACK) of in-service teachers: A study in Turkish public schools. *International Journal of Educational Technology*, *5*(2), 46–58. Retrieved from https://educationaltechnology.net/ijet/index.php/ijet/article/view/58

Abstract: "In the current study, the technological pedagogical content knowledge (TPACK) perceptions of Turkish in-service teachers working in public schools were investigated. The survey method was employed to investigate the in-servive teachers' perceptions of TPACK in terms of some demographic variables. The participants of the study consisted of volunteering in-service teachers (n = 200) from different public elementary and high schools. The results of the study indicated that the in-service teachers' TPACK perceptions were affected by their gender, occupational experience, educational level, teaching level, and taking educational computer and Internet use seminar variables. The results also revealed that the in-service teachers' perceptions of TPACK were at a moderate level. The results suggested that further efforts are required to develop the in-service teachers' TPACK perceptions in order to integrate ICTs into teaching and learning process effectively in the classroom."

Cai, J., Yang, H. H., Gong, D., MacLeod, J., & Zhu, S. (2018). Understanding the continued use of flipped classroom instruction: A personal beliefs model in Chinese higher education. *Journal of Computing in Higher Education*. Advance online publication. https://doi.org/10.1007/s12528-018-9196-y

Abstract: "The flipped classroom has gained much attention for its pedagogical success in higher education. However, continued use of this technology-supported instructional approach has been problematic. To support the success and continuation of flipped classroom implementation, this study employs structural equation modeling techniques to examine the relationships between five key factors of influence (computer self-efficacy, perceived technological pedagogical content knowledge, perceived ease of use, perceived usefulness, perceived organizational support) and instructors' continued use intention. The results identify that instructors' perceived organizational support and perceived technological pedagogical content knowledge are the only factors examined that directly impact continued use intention. Instructors' technological pedagogical content knowledge also mediates between perceived organizational support and computer self-efficacy to continued use intention. These findings provide empirical evidence of such relationships and indicate that personal beliefs regarding technology itself are not the strongest factors influencing the continued use of flipped classroom instruction. Rather, instructors' beliefs relating to their environmental surroundings and personal knowledge regarding technology usage for instructional purposes are the key factors of instructors' continued use intention in Chinese higher education."

Donitsa-Schmidt, S., & Topaz, B. (2018). Massive open online courses as a knowledge base for teachers. *Journal of Education for Teaching*, *44*(5), 608–620. https://doi.org/10.1080/02607476.2018.1516350

Abstract: "This research investigated an initiative to familiarize pre-service teachers with Massive Open Online Courses (MOOCs) as an example of Open Educational Resources (OERs). Student teachers in one faculty in a teacher education college in Israel were given the option to register on an international MOOC for credit. The purpose of the research was to examine the attitudes of the 84 students who chose to study in a MOOC towards their learning experience. Data were collected from students' reflections upon completion of the course. Findings reveal that all those enrolled in the MOOC successfully completed the course, expressed positive attitudes towards their learning experience and a desire to participate in more courses in the future. Students' reflections reveal gains not only in content knowledge but also in pedagogical knowledge, pedagogical content knowledge and technological pedagogical and content knowledge. Results indicate that MOOCs hold great potential for teachers' continuous professional development and lifelong learning."

Elrick, D., Yu., J., & Hargrave, C. (2018). Integrating online instruction and hands-on laboratory activities for summer learning for students of color: A design case in forensic science. *Journal of Online Learning Research*, *4*(3), 263–294. Retrieved from https://www.learntechlib.org/primary/p/183592/

Abstract: "The popularity of TV shows such as Crime Scene Investigation (CSI) has generated high school students' interest in forensics. Yet, forensic science is not commonly accessible to students, and especially students of color who often attend under-resourced high schools. This

article presents the design, development, and evaluation of an online forensics course created for high school students of color who were part of an informal science, technology, engineering, and mathematics (STEM) educational development program. Two essential elements guided the course design: the target learners (high school students of color) and integrating online instruction and hands-on laboratory activities involving real-world forensic analyses. The design of the online course provided a STEM content-rich, self-directed, informal learning environment that effectively engaged high school students of color in meaningful forensics learning during the summer."

Fan, L. C., Salleh, S., & Laxman, K. (2018). Embedding video technology in enhancing the understanding of the biology concept of breathing: A Brunei perspective. *E-Learning and Digital Media*, *15*(5), 217–234. https://doi.org/10.1177/2042753018797260

Abstract: "This study was carried out in an attempt to investigate the impact of embedding video technology into classroom lessons designed using technological using technological pedagogical content knowledge (TPACK) framework in improving students' conceptual understanding, focused on the concept of breathing. This study hypothesized that embedding video technology into classroom teaching would assist students in visualizing the dynamic biological processes, while improving students' conceptual understanding of the biology concept of breathing. This study sought to answer two research questions: (1) What are the students' misconceptions on breathing? (2) Does the integration of technology in lesson improve students' understanding of the concept? In this study, participants underwent four cycles of interventions, reflecting on the four knowledge dimensions of the TPACK framework (declarative, procedural, schematic and strategic). Mixed research method was employed in this study. Drawing-writing technique, pre- and post-tests and students' interviews were used to collect data. The quantitative data derived from the students' pre- and post-tests scores were analysed using SPSS paired sample t-test, while the qualitative data obtained from the drawing-writing technique and students' interviews were thematically analysed based on the content. Results of this study indicated that there was a significantly greater improvement in students' conceptual understanding of the biology concept of breathing after the interventions, thus demonstrating the positive impact of embedding video technology into classroom lessons planned using TPACK framework."

Goncalves, B. M. F., & Osorio, A. J. (2018). Massive open online courses (MOOCs) to improve teachers' professional development. *RE@D – Revista de Educacao a Distancia e Learning*, *1*(1), 52–63. Retrieved from https://journals.uab.pt/index.php/lead_read/article/view/146/127

Abstract: "Although the integration of ICT in education is currently on the agenda of educational institutions, it may be difficult to understand the technological progress and the networked society uniquely based on existing learning theories. As a kind of answer to this need, the notion of connectivism has emerged. Connectivism deals with knowledge as something distributed in a network of connections. Considering Massive Open Online Courses (MOOC) as an expression of connectivism, this research attempts to study

MOOC as a way to understand the process of professional development of teachers in a connectivist environment. This research adopted Technological Pedagogical and Content Knowledge (TPACK) as a theoretical referential to examine in detail, the process of professional development of teachers in the MOOC context. Through an in-depth study of this process, it was intended to identify the innovations to be introduced into the operation of MOOC in view of improving the professional development of teachers. The results of this research reveal that the process involved in the professional development of teachers in MOOC is quite complex and therefore, determined by a variety of identified dimensions."

Hong, B. V., Tuyen, T., & Luong, N. T. (2018). Teaching capacity of technology teachers: Applying in the training program of technology teacher in Vietnam. *American Journal of Educational Research*, *6*(12), 1662–1667. doi:10.12691/education-6-12-11

Abstract: "Teaching capacity, learning outcomes, and the training program of technology teacher in this study aim to guide the training of technology teachers under the program on general education renovation in Vietnam. Based on the analysis of the Technological Pedagogical Content Knowledge (TPACK) model, the impact of the 4th industrial revolution, and the requirement of technology teacher's capacity, this study presents the teaching capability of technology teachers including the combination of core competencies (necessary skills in the 21st century), competency in engineering and technology, competency in teaching methods, and competency in the application of technology in teaching. The combination of these competencies in the training program of technology teachers will contribute to the development of technology teachers with full of core competencies, technical and technological knowledges, teaching methods, technology application and teaching method renovation."

Jiang, S., & Rafeeq, A. (2018). Web-based course delivery approach in teaching mass communication courses. *International Journal of Information and Education Technology*, *8*(6), 418–421. https://doi.org/10.18178/ijiet.2018.8.6.1074

Abstract: "This paper explores how the changing education technology and learning environment in the digital era are transforming the traditional teaching and learning experience. Based on TPACK model, a combination of technological, pedagogical and content knowledge strategy is adopted. Different course delivery platforms were introduced and their advantages and disadvantages were discussed. Examples of courses developed and delivered through website builders and blogs are showcased on how web-based course delivery approach can enhance teaching and learning experience in media and journalism courses."

Jwaifell, M., Abu-Omar, R., & Al-Tarawneh, M. (2018). The readiness of Arabic language teachers for integrating flipped classrooms: Case of Ma'an. *International Journal of Instruction*, *11*(4), 855–868. https://doi.org/10.12973/iji.2018.11454a

Abstract: "This paper investigates the readiness degree among Arabic language teachers in Ma'an Directorate of Education for integrating flipped classroom in teaching according to

Technological, Pedagogical and Content Knowledge TPACK framework and its domains. The study sample consisted of (118) Arabic language teachers; (82) of them responded to a questionnaire that measured their readiness. The researchers used descriptive statistics, ANOVA and T-test. The data analyses revealed significant differences among teachers' readiness in a high degree. Two sample t-test showed female teachers' readiness higher than male teachers at the domains: CK, PK, PCK, TPK and TPCK. Results of ANOVA revealed that experience of teachers' readiness do not differ significantly. The study recommended the focus on integrating flipped classrooms within learning environments."

Lane, R., & Caldis, S. (2018). Participatory action research: A tool for promoting effective assessment and building the pedagogical content knowledge of secondary geography teachers. *Geographical Education*, *31*, 16–30. Retrieved from https://search.informit.com.au/documentSummary;dn=095425150629829;res=IELAPA

Abstract: "This paper describes the results of an action research project undertaken as a partnership between Macquarie University and Geography teachers from an independent school in regional New South Wales (NSW), Australia. The project focused on the teaching of river landforms and processes, a component of the Biophysical Interactions topic in the NSW Stage 6 Geography syllabus. The aim of the research was to provide four teachers with feedback about depth and accuracy of students' content knowledge, the teachers' knowledge of common student conceptions, and the extent to which the school's fieldwork program promoted cognitive disequilibrium and constructive confusion, affective states required for deep conceptual change. This feedback was used as a prompt for professional reflection and to stimulate conversations about improvements that could be made to the teachers' knowledge and practice. The findings suggest that this form of action research can be an effective tool for enhancing teachers' pedagogical content knowledge (PCK) including their knowledge of evidence-based assessment practices in Geography."

Lisene, L. N., & Jita, T. (2018). Exploring the integration of modern technologies in the teaching of physical science in Lesotho. *Perspectives in Education*, *36*(1), 111–127. https://doi.org/10.18820/2519593x/pie.v36i1.8

Abstract: "The aim of the paper is to explore the knowledge base of high school physical science teachers, from selected high schools in Lesotho, regarding the integration of information and communication technologies (ICTs) into the curriculum. The new physical science curriculum in Lesotho requires the use of ICTs for teaching. The teachers' use of ICTs was explored through a questionnaire based on the technological pedagogical content knowledge model (TPACK). Data were analysed using the statistical analysis software (SAS) and the results showed that 77% of the teachers used ICTs for teaching, while 80% used them for non-teaching activities. The mean score for teachers' TPACK was 2.88. This score is below the average of three for the Likert points of the items on teachers' TPACK, which was set as the acceptable level for this paper. Therefore, the study concludes that Lesotho teachers do use ICTs for teaching physical science even though their TPACK may be below average. Their low TPACK may be an indication that

they used ICTs to get more information about the content, rather than for delivering the lessons. There is thus an urgent need to increase the support for teachers to maximise the use of ICTs for teaching."

Loong, E. Y. K. & Herbert, S. (2018). Primary school teachers' use of digital technology in mathematics: The complexities. *Mathematics Education Research Journal*, *30*(4), 475–498. https://doi.org/10.1007/s13394-018-0235-9

Abstract: "This paper seeks to theorise primary teachers' degree of integration of digital technology in the mathematics classroom. In an age where digital technology use is ubiquitous, the issues surrounding teachers' choice, and ultimately their uptake of digital technologies in the classroom, is an area that need to be further unpacked. Cross-case analysis of the two teachers' uptake of digital technologies in their classroom, their pedagogical approaches and the reason for their choices provide insight into teachers' technological, pedagogical and content knowledge (TPACK). Differences in the way the teachers use digital technology in their classroom seem to be connected to their TPACK developmental stage."

Mannila, L. (2018). Digitally competent schools: Teacher expectations when introducing digital competence in Finnish basic education. *International Journal of Media, Technology, and Lifelong Learning*, *14*(2), 201–215. Retrieved from https://journals.hioa.no/index.php/seminar/article/view/2980

Abstract: "The increased exposure to technology raises a need for understanding how the digital world works, just as we learn about the physical world. As a result, countries all over the world are renewing their school curricula in order to include digital competence, computer science or other similar content. In this paper, we provide insight into what teachers see as crucial aspects when implementing a new curricula introducing digital competence as a transversal element. We have analysed 86 Finnish teachers' descriptions of digitally competent schools and digitally competent personnel, in order to identify a list of prerequisites that can be helpful to school leaders who are to drive the change at their local schools."

Marwan, A., & Sweeney, T. (2018). Using activity theory to analyse contractions in English teachers' technology integration. *The Asia-Pacific Education Researcher*. Advance online publication. https://doi.org/10.1007/s40299-018-0418-x

Abstract: "This paper reports on a qualitative research project investigating the integration of technology by three English teachers in a public secondary school in Indonesia. Third generation activity theory and Engeström and Sannino's (J Organ Change Manag 24(3):368–387, 2011) methodological framework for the identification and analysis of different types of discursive manifestations of contradictions are used to identify tensions within and between the activity systems of the teachers and school management related to the expectation that teachers make use of the school's investment in technology. Four types of contradictions are identified: a dilemma related to teachers' perceived value and use of technology for personal and professional purposes; a conflict focused on the support required for teachers' technology

integration; a conflict related to teachers' workload and a critical conflict related to the silencing of teachers in decision making. The identification of these contradictions highlights the necessity for policy makers, school leaders, teachers and the research community to work collaboratively to ensure that students have opportunities to use technology for their social, civic and economic well-being."

Masrifah, M., Setiawan, A., Sinaga, P., & Setiawan, W. (2018). Profile of senior high school in-service physics teachers' technological pedagogical and content knowledge (TPACK). *Journal of Physics: Conference series*, *1097*, 1–6. https://doi.org/10.1088/1742-6596/1097/1/012025

Abstract: "This research is aimed to find out TPACK of high school in-service Physics teachers in North Maluku by using TPACK survey instrument that consist of 7 components, namely Technological Knowledge (TK), Content Knowledge (CK), Pedagogical Knowledge (PK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK) and TPACK in Likert scale. The data of TPACK perceptions were analysed using descriptive statistics, whereas teachers' TPACK differences in gender and experience of teaching were analysed using Mann Whitney test by SPSS 20 because the samples were small samples. The result of data analysis shows that TPACK perception of senior high school in-service Physics teachers is still in the low category. The components are TK, TCK, TPK, and TPCK that related to technology. Based on gender data analysis, it is known that there is significant difference only on TCK component, whereas based on teachers' experience of teaching, significant differences were found in components of PK, PCK, and TPCK. Based on these research result can be conclude that TPACK of teachers are still constrained on components related to technology so that the ability of teachers in integrating technology in learning is still not maximized."

Murcia, K., Campbell, C., & Aranda, G. (2018). Trends in early childhood education practice and professional learning with digital technologies. *Education Futures for the Digital Age: Theory and Practice*, *68*(3), 249–264. https://doi.org/10.14712/23362189.2018.858

Abstract: "This literature-based article explores key trends in the integration of digital technologies in education and aims to highlight issues and challenges in the relationship between technology, pedagogy and early years' education practices. The article explores how technology, teacher training initiatives and productive play-based pedagogy could be used to improve digital literacy outcomes for early childhood learners. While situated within the Australian context, more global literature is also reviewed to provide an international perspective. This review of trends in the integration of digital technologies in education is timely due to the national and international focus on STEM (Science, Technology, Engineering and Mathematics) education, arguably for economic sustainability and the quality standards expected in early childhood education. The role of digital technologies in early childhood is increasingly discussed and negotiated in learning centres. Educators are wanting support in understanding how young children can be creators of technology rather than simply being consumers of digital products."

Mutanga, P., Nezandonyi, J., & Bhukuvhani, C. (2018). Enhancing engineering education through technological pedagogical and content knowledge (TPACK): A case study. *International Journal of Education and Development using Information and Communication Technology (IJEDICT)*, *14*(3), 38–49. Retrieved from http://ijedict.dec.uwi.edu/viewarticle.php?id=2445

Abstract: "This study analysed the status of TPACK knowledge and its impact on the quality of technical and engineering education. The research was a case study of 20 lecturers who were purposefully sampled from the School of Engineering and Technology at a university in Zimbabwe. The lecturers had no prior training in pedagogy. The purpose of the study was to establish the level of appreciation of TPACK among the lecturers and how they were integrating it in their teaching. Mixed research methods were employed. A questionnaire on Likert scale was used and descriptive statistics performed on the data to get frequencies and means. Follow-up interviews were done to triangulate questionnaire data in the determination of lecturers' views on the use of TPACK to enhance understanding as effective strategies to use it in teaching engineering students. The study found out that most lecturers (70%) were confident of their pedagogical competencies. However, on the adoption and use of technology in their teaching, 60% agreed that they could adopt whilst 55% were still thinking about how technology could be used in teaching. The frequency of use of ICT technologies among lecturers is quite high (80%) besides the lack of technology use to support students with disabilities. The lecturers (70%) viewed TPACK as an enhancement to improved quality of technical and engineering education. ICT use has been perceived as to improving the quality of engineering teaching and learning. It can be concluded that engineering lecturers are competent in their knowledge about individual components of TPACK but not on the integration of these components for effective teaching besides them agreeing that it is important to have a balanced combination of knowledge with respect to content knowledge, methods, and technologies. The research recommends TPACK capacitation of lecturers through in-service training."

Ok, M. W., Hughes, J. E., & Boklage, A. (2018). Teaching and learning biology with iPads for high school students with disabilities. *Journal of Educational Computing Research*, *56*(6), 911–939. https://doi.org/10.1177/0735633117713113

Abstract: "This descriptive case study examined the first year of iPad-supported teaching and learning in a high school modified biology class. Results revealed that the iPad practices replaced, amplified, and transformed pedagogy and learning, but they predominantly supported general learning or instructional practices with little science specificity. A strong technology vision and collaborative planning with teachers were strong supports for iPad integration. The teacher's deep pedagogical and content knowledge and positive attitude toward using iPads were significant in persevering through barriers to integration, such as increased time to plan lessons, little professional learning, and technical difficulties. While iPads effectively supported learning in this special education classroom, the discussion suggests for more content-focused iPad integration and deeper technological content knowledge among teachers."

Oktalia, D., & Drajati, N. A. (2018). English teachers' perceptions of text to speech software and Google site in an EFL classroom: What English teachers really think and know. *International Journal of Education and Development using ICT*, *14*(3), 183–192. Retrieved from http://ijedict.dec.uwi.edu/viewarticle.php?id=2513

Abstract: "21st century learning may help teachers in getting various listening material easily. Even though it is easy to get listening materials, there is no guarantee that every listening material will meet the students' needs or learning objective. One possible solution that can be used is by having Text to Speech program as a tool for creating listening materials based on students' needs or learning objectives. As such, this study aims to investigate EFL teachers' perceptions toward the use of Text to Speech program in creating listening materials by using TPACK model. Text to Speech could be considered as the solution for the lack of listening material. This study used qualitative method with individual interview technique. There were eight EFL teachers who served as the sample of this research. Several steps were done in order to gain teachers' perceptions toward the use of Text to Speech in creating listening material. First, a computer training was done in order to make EFL teachers familiar with the text to speech program; second, the listening material produced by teachers was put in Google site to be delivered to students, after that teachers tried the prepared listening material and Google site feature; next, the interviewes were done to gain EFL teachers' perceptions toward Text to Speech program and Google site. The findings show that EFL teachers give positive responses toward the integration of Text to Speech program by using TPACK model. EFL teachers found it useful to use this digital approach in the language learning process."

Rahmi, E. (2018). The analysis of pedagogical content knowledge of teacher candidates. *Advances in Economics, Business and Management Research*, *57*, 604–609. https://doi.org/10.2991/piceeba-18.2018.11

Abstract: "Students as prospective teachers have unique characteristics, they are required not only to understand the materials, but also to be able to teach the materials to others when they practice to be teachers, or become actual teachers. This study aims to determine and analyze the pedagogical content knowledge of prospective economic teacher. The population on this research was students who attended micro teaching course. The sample was drawn by using purposive sampling approach. Data were collected in observation sheets, consist of materials mastery, the ability in giving apperception and motivation, selection of methods or learning strategies, selection of media and sources, the ability to performance assessment and the ability to involve learner in learning process. The result of research show that in general, the pedagogical content knowledge of teacher candidates is still in the 'sufficient' and 'good' category; thus, it needs a lot of improvement."

Ramoroka, T., & Tsheola, J. (2018). Blended learning and educators' digital technology literacy for the TV white spaces pilot project in Mankweng Circuit, South Africa. *International Journal of International of Educational Sciences*, *20*(1–3), 49–63. doi: 10.1080/09751122.2017.1305734

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Abstract: "This paper examines the levels of information and communication technology (ICT) literacy among educators at three high schools in Mankweng Circuit where the TV White Spaces Pilot Project has been implemented since July 2013 to promote blended learning. The paper examines survey results among 24 educators in order to demonstrate that the T V White Spaces Pilot Project has not revolutionized teachers' confidence in computer and ICT literacy, e-pedagogies nor digital informatics. Beyond infrastructure resourcing, successful implementation of blended learning is largely dependent upon "computer and information literacy" among both students and educators, requiring therefore investments in time and energy for acquisition of instructional methodologies, strategies and skills. For this reason, the ubiquity and inevitability of e-learning in South Africa could potentially underestimate the complexities of establishing pedagogic abilities, skills and confidence in the attendant digital technology informatics among educators, who are challenged to blend digital informatics with conventional didactics."

Singh, K. K. K., Yamat, H., & Wahi, W. (2018). Teachers' beliefs on technological fusion in teaching ESL students. *Creative Education*, *9*, 2125–2136. Retrieved from http://www.scirp.org/journal/ce

Abstract: "Studies on the effectiveness of technology have shown that it enhances students in language learning and helps gain their involvement. Nevertheless, there is still resistance among teachers in using technology in the language classrooms due to the rapid advancements of technology. The aim of the study reported in this article was therefore to gather testimonial insights on teachers' beliefs about technology and its fusion to illuminate how English as a second language (ESL) teaching and learning is eased and made meaningful in classrooms. This paper reports on a case study that looks into primary school teachers' beliefs on technological fusion in teaching ESL students. Data were collected from three teachers of different teaching experiences through interviews and observations and themes were generated through constant comparative and thematic analysis; assisted with the use of ATLAS ti.7 software. Findings indicate that despite positive beliefs that the fusion of technology assists language teaching and learning, not all teachers embrace technology in their classrooms as schools especially in rural areas lack facilities to aid the use of technology. This study implies that there is a need to equip all schools with devices and equipment that aid the fusion of technology in language teaching."

Song, M. J. (2018). Learning to teach 3D printing in schools: How do teachers in Korea prepare to integrate 3D printing technology into classrooms? *Educational Media International*, *55*(3), 183–198. https://doi.org/10.1080/09523987.2018.1512448

Abstract: "3D printing implementation in educational contexts has gained considerable attention in recent years. However, research shows that both in-service and pre-service teachers lack digital literacy and the confidence required to teach this emerging technology. This study reports the current challenges and opportunities in 3D printing education in Korea and identifies the range of knowledge required for teachers to integrate 3D printing technology into classrooms in meaningful ways. The technological, pedagogical, and content knowledge

(TPACK) framework was used to analyze the certificate program for 3D printing educators and in-service teachers' practices. The findings from interviews with 10 in-service teachers and participant observation in the 3D printing training workshop for pre-service teachers revealed that technological knowledge is overly emphasized in the 3D printing teacher training curriculum. Thus, many in-service teachers develop their content knowledge and pedagogical knowledge by exchanging ideas with other teachers online and running project-based courses with flipped classroom approaches. Two potential paths were discovered for developing curricula that cross over the domains of the TPACK framework to successfully integrate the technology into classrooms: collaboration between teachers in different subject areas and industry experts to develop technical knowledge and curriculum, and contextualizing 3D printing technology in relation to open-source digital culture."

Tseng, J–J., Cheng, Y–S., & Yeh, H–N. (2019). How pre-service English teachers enact TPACK in the context of web-conferencing teaching: A design thinking approach. *Computers & Education*, *128*, 171–182. https://doi.org/10.1016/j.compedu.2018.09.022

Abstract: "Technological Pedagogical Content Knowledge (TPACK) is a teacher knowledge construct in relation to integrating technology into teaching. However, whether this theoretical concept exists in practice remains contentious. To ascertain the nature of TPACK, the present study aimed to understand how six pre-service English teachers enacted various forms of TPACK through design thinking while considering contextual problems that impacted on their web-conferencing teaching over the course of 14 weeks. This study examined the design conversations in which six distance teachers discussed ways to design online teaching materials and activities as well as to solve any contextual problems encountered. Through quantitative content analysis of coded post-teaching discussions and qualitative analysis of interviews, it was found that while the teachers' discussions conspicuously displayed an orientation towards Pedagogical Content Knowledge, as opposed to technology-based knowledge, their discussions were particularly not associated with Technological Pedagogical Knowledge. In addition, two contextual factors were found to influence their web-conferencing teaching: technical problems related to sound quality were identified as a micro-level contextual factor while the teachers' concerns about their students' prior knowledge and short attention spans were viewed as a student-centric contextual factor. These findings provide insights into how individual TPACK subdomains were enacted through design thinking that enabled the teachers to overcome contextual problems. The present study contributes to our understanding of how TPACK enactment is mediated by the context, empirically validating TPACK construct in practice through design thinking."

Vereshchahina, T., Liashchenko, O., & Babiy, S. (2018). English language teachers' perceptions of hybrid learning at university level. *Advanced Education*, *10*, 88–97. https://doi.org/10.20535/2410-8286.148368

Abstract: "The rapid growth of modern technologies has facilitated the emergence of hybrid learning as a specially designed training system that combines face-to-face learning and remote phase. Since this teaching mode is relatively new to university English language instructors,

there is an urgent need to investigate ESL teachers' perceptions of hybrid learning at university level. Therefore, the purpose of this pilot study is to analyse the teachers' self-assessment of TPACK (Technological, Pedagogical and Content Knowledge) as an important prerequisite of successful incorporation of computer technologies and I-tools into a curriculum, and consider advantages and disadvantages of hybrid learning in university teachers' working environments. The analysis of quantitative and qualitative data has revealed that teachers have high content, pedagogical and pedagogical content knowledge whereas technological knowledge and technological content knowledge appear to be lower. The latter can be explained by the lack of information support and relevant digital classroom equipment in their educational institutions as it was indicated in the list of disadvantages. At the same time, the teachers' responses have shown that advantages (a student-centred approach, an easy access to learning materials and assessment criteria, a wide range of online tools to learn English) outnumber the disadvantages. In general, the ESL teachers' perceptions of hybrid learning are positive. However, they need to improve their technological knowledge and technological content knowledge. Also, better-equipped classrooms could create more favourable learning environments. Positive changes in these spheres could lead to the more effective implementation of hybrid learning in teaching English at university level."

Yang, C. (2018). Research on the mixed teaching mode on TPACK in software testing course. *Recent Patents on Computer Science*, *11*(4), 302–311. https://doi.org/10.2174/2213275911666181011150237

Abstract: "Background: Software testing is a common course in universities. It mainly explains the principles and methods of software testing and the use of testing tools. It is committed to develop software testing talents. At present, some urgent problems have appeared in the course of software testing. For example, teaching content lacks practical ability, students' interest in learning is not high, personnel training has far behind market lags demand. TPACK is a subject teaching knowledge of integrated technology, which was proposed by American scholar Kohler and Mishra on the basis of the subject teaching knowledge. To research on TPACK, domestic and overseas scholars have taken up large number of theoretical and practical since 2005. Through research, it is agreed that the study of TPACK can improve the ability of teachers to master and use information technology. For the problems in software testing course, TPACK is introduced to improve it.

Methods: According to the existing teaching methods, a mixed teaching model using TPACK (MTMTPACK) is proposed in this paper. Combined with the three basic elements of TPACK framework and the characteristics of four compound elements, this mode is deeply integrated into the software testing course. Moreover, TPACK's learning ideas have been creatively put forward. In the MTM-TPACK teaching mode, it not only utilizes multimedia, network learning, WeChat and other ways are used to enhance students' interest in learning but also adopts some teaching method (such as case teaching method, task driven method and so on) to improve students' enthusiasm and initiative in learning. In this way, students not only can fully participate in the teaching process of software testing, and their learning effect can also be improved at the same time. In order to compare the test results, a statistical method is introduced to analyze the experimental results.

Results: The reform of most teaching methods focuses on one aspect of improvement. The improvement of the MTM-TPACK teaching mode is aimed at the whole process. In the teaching effect between the experimental class and the ordinary class, the whole process of the test is designed. Through the methods of questionnaire survey and data collection, the test data were sorted and analyzed. The test results were compared in five aspects, such as score results, students' practical learning ability, knowledge expansion ability, learning interest and satisfaction, communication and team cooperation. The test results show that the new teaching method is superior to the traditional teaching method in terms of indicators.

Conclusion: This paper presents a mixed teaching mode in software testing course. This mode solves the problems in current software testing teaching, for example poor teaching effect. It not only improves the comprehensive quality of students' practical operation ability and teamwork ability, but also provides good conditions for students to engage in software testing. The method proposed in this paper lays a solid foundation for their future development, which can be applied to the practical courses of computer science and can contribute to the improvement of computer majors' practical ability."

Books

M. Khosrow-Pour (2019). *TPACK: Breakthroughs in research and practice.* Hershey, PA: IGI Global. https://doi.org/10.4018/978-1-5225-7918-2

Abstract: "Educational technologies are becoming commonplace entities in classrooms as they provide more options and support for teachers and students. However, many teachers are finding these technologies difficult to use due to a lack of training and instruction on how to effectively apply them to the classroom. **TPACK: Breakthroughs in Research and Practice** is an authoritative reference source for the latest research on the integration of technological knowledge, pedagogical knowledge, and content knowledge in the contexts of K-12 education. Highlighting a range of pertinent topics such as pedagogical strategies, blended learning, and technology integration, this publication is an ideal resource for educators, instructional designers, administrators, academicians, and teacher education programs seeking current findings on the implementation of technology in instructional design."

Niess, M. L., Gillow-Wiles, H., & Angeli, C. (Eds.), *Handbook of research on TPACK in the digital age.* Hershey, PA: IGI Global. https://doi.org/10.4018/978-1-5225-7001-1

Abstract: "The impact of digital technologies in education has called for teachers to be prepared to facilitate their students' learning through communication, collaboration, critical thinking, and creativity. In order to create ideal learning environments for their students, teachers must develop a more integrated knowledge for infusing digital technologies as learning tools, a knowledge referred to as TPACK.

The Handbook of Research on TPACK in the Digital Age provides innovative insights into teacher preparation for the effective integration of digital technologies into the classroom. The content within this publication represents the work of online learning, digital technologies, and

pedagogical strategies. It is designed for teachers, educational designers, instructional technology faculty, administrators, academicians, and education graduate students, and covers topics centered on classroom technology integration and teacher knowledge and support."

Chapters

Abera, B. (2019). Applying a technological pedagogical content knowledge framework in Ethiopian English language teacher education. In M. Khosrow-Pour (Ed.), *TPACK: Breakthroughs in research and practice* (pp. 273–288). https://doi.org/10.4018/978-1-5225-7918-2.ch013

Abstract: "Technological Pedagogical Content Knowledge (TPACK) has emerged as a useful frame for instructional technology-enhanced education. This chapter addresses the existing literature on technological pedagogical content knowledge framework and of teacher education in Ethiopia in general and English language teacher education in particular. Data were collected through a structured questionnaire, interviews, classroom observations, and documents. The results revealed that the existing literature failed to demonstrate the application of TPACK in English language teacher education in the country. The technological pedagogical content knowledge of classroom English language teachers was also found to be low. Classroom teachers applied their pedagogical content knowledge while teaching English language through televised instruction like the conventional instruction. They were seldom observed applying their technological pedagogical content knowledge. Finally, based on the results and the conceptual framework of TPACK, implications for the Ethiopian secondary school teacher preparation programs are outlined and further studies are suggested."

Andrade, M. J. P., & Coutinho, C. P. (2019). Flipped classroom, cognitive flexibility theory, and cognitive operators of complexity: Developing TPACK in pre-service teacher education. In M. L. Niess, H. Gillow-Wiles, & C. Angeli (Eds.), *Handbook of research on TPACK in the digital age* (pp. 199–223). https://doi.org/10.4018/978-1-5225-7001-1.ch010

Abstract: "Researchers have presented several training models for teachers with the goal of developing TPACK. However, it is necessary to investigate how learning theories can help in the elaboration of these models. It is also essential to use a theoretical framework that provides guidance on how to deal with this complexity involved in TPACK and teacher training. This problem motivated the investigation of how a course based on a model that uses the cognitive flexibility theory (CFT), the cognitive operators of complexity and implemented in the flipped classroom can help in the development of the TPACK. The investigation was carried out through a case study. Participants were pre-service teachers at a Brazilian university. Data analysis allowed to identify that the course helped in the development of the TPACK by the teachers and to determine the positive aspects and the difficulties faced in the implementation of the proposed model."

Angeli, C., & Christodoulou, A. (2019). Developing pre-service teachers' technological pedagogical content knowledge with E-TPCK. In M. L. Niess, H. Gillow-Wiles, & C. Angeli (Eds.), *Handbook of research on TPACK in the digital age* (pp. 350–364). https://doi.org/10.4018/978-1-5225-7001-1.ch016

Abstract: "The authors discuss the design of e-TPCK, a self-paced adaptive electronic learning environment that was integrated in a second-year educational technology course to engage pre-service teachers' in rich learning experiences in order to develop their technological pedagogical content knowledge (TPCK) in a personalized way. The system deploys a technological solution that promotes teachers' ongoing TPCK development by engaging them in rich and valuable personalized learning experiences through the use of technology-infused design scenarios, while taking into account teachers' diverse needs, information processing constraints, and preferences. Results from an experimental research design study revealed statistically significant differences between the control group and the experimental group in favor of the experimental group, signifying that students in the experimental group who learned with e-TPCK outperformed the students in the control group in terms of developing TPCK competencies."

Ayieko, R. A., Gokbel, E. N., & Akcay, A. O. (2019). Building knowledge for technology integration in learning to teach secondary school mathematics: Building technology knowledge. In M. L. Niess, H. Gillow-Wiles, & C. Angeli (Eds.), *Handbook of research on TPACK in the digital age* (pp. 24–46). https://doi.org/10.4018/978-1-5225-7001-1.ch002

Abstract: "Teachers' knowledge for teaching mathematics in secondary school is incomplete without the inclusion of knowledge of technology integration in teaching. Developing technology pedagogical content knowledge (TPACK) of pre-service teachers is essential in teacher preparation programs because PSTs gain knowledge of how to use technology in mathematics teaching before beginning their practice. This study investigates how preservice mathematics teachers' TPACK emerges during the secondary mathematics methods and field-based courses. The instructors supported the growth of PSTs' knowledge for teaching secondary mathematics and integrating technology in the method courses. The evidence of TPACK knowledge included data from lesson plans and lesson reflections, technology presentations, and semi-structured exit interviews through content analysis. Recommendations for policy and practice are elaborated."

Blankenship, R. J. (2019). Transforming preservice teacher TPACK by transforming faculty digital agency: Case studies from the provost's inaugural digital learning initiatives fellows. In M. L. Niess, H. Gillow-Wiles, & C. Angeli (Eds.), *Handbook of research on TPACK in the digital age* (pp. 131–153). https://doi.org/10.4018/978-1-5225-7001-1.ch007

Abstract: "In 2016, the Office of the Provost at Florida Agricultural and Mechanical University initiated a highly competitive faculty digital learning initiative (DLI) to promote student-centered learning by retooling existing courses to reflect current and emerging technology trends. For this chapter, the experiences of four fellows were considered within the TPACK

framework level of use (LoU) structure in addition to considerations of how the face-to-face to digital transformation were perceived by fellows in terms of what they knew about their pedagogic methods prior to, during, and subsequent to completion of the fellowship. Additionally, descriptions of how each fellow retooled the curriculum and construct of her/his course to reflect better the needs of the 21st century learner will be cross-analyzed through event-flow networks against her/his re-envisioned personal teaching philosophy to establish if pedagogic transformation actually occurred across the digital plane."

Bolaji Adegbenro, J., Gumbo, M. T., & Olugbara, O. O. (2019). Exploring technological knowledge of office data processing teachers: Using factor analytic methods. In M. Khosrow-Pour (Ed.), *TPACK: Breakthroughs in research and practice* (pp. 155–184). https://doi.org/10.4018/978-1-5225-7918-2.ch007

Abstract: "This study applied factor analysis for exploring technological knowledge of beginner and veteran Office Data Processing (ODP) teachers at Further Education and Training (FET) or Technical and Vocational Education and Training (TVET) colleges in South Africa. These ODP teachers use Information Communication Technology (ICT) in the technology-enhanced classrooms. The Mishra & Koehler (2006) Technological Pedagogical Content Knowledge (TPACK) framework was extended by replacing Technological Knowledge with Procedural Functional Knowledge (PrFK) to realise the PrFPACK theoretical framework that enabled the researchers to holistically explore the contextual technological knowledge of teachers in the digital classroom environment. We developed an inventory of 65 comprehensive measures based on the PrFPACK framework and validated the inventory on a dataset of responses from 107 ODP teachers. The findings of this study generally revealed that Procedural Functional Content Knowledge is the most important factor in explaining the technological knowledge of ODP teachers."

Byker, E., Putnam, S. M., Polly, D., & Handler, L. K. (2018). Examining elementary education teachers and preservice teachers' self-efficacy related to technological pedagogical and content knowledge (TPACK). In C. B. Hodges (Ed.), *Self-efficacy in instructional technology contexts* (pp. 119–140). https://doi.org/10.1007/978-3-319-99858-9_8

Abstract: "Self-efficacy is the belief people have about their capabilities to produce effective results related to the events and challenges that affect their lives (Bandura, Self-efficacy: The exercise of control. New York: Freeman, 1997). Self-efficacy represents a powerful influence on the behaviors of teachers due to its impact on instructional choice, effort, and persistence. Purposeful technology integration in teaching is an example of how choice, effort, and persistence converge as teachers make decisions about the types of tools they use to support their teaching. Such technology integration brings together technological knowledge, pedagogical knowledge, and content knowledge—known as the TPACK framework. Few studies have been conducted examining preservice and in-service teachers' self-efficacy for TPACK. This study uses a survey design to examine preservice and in-service teachers' (n = 89) self-efficacy to integrate educational technology in their teaching practice. The study also describes and

reports on ways that teacher educators support self-efficacy development of preservice and in-service teachers."

Dick, T. P., & Burrill, G. F. (2019). Design and implementation principles for dynamic interactive mathematics technologies. In M. Khosrow-Pour (Ed.), *TPACK: Breakthroughs in research and practice* (pp. 372–400). https://doi.org/10.4018/978-1-5225-7918-2.ch018

Abstract: "Design and implementation principles are described for choosing and using dynamic interactive mathematics technologies in support of mathematics learning and teaching. The design principles value technologies that enable meaningful and purposeful actions by students resulting in immediately visual consequences. The implementation principles emphasize using these technologies for important mathematics to pose rich tasks and ask good questions that demand sense making and reasoning and engage students in the mathematical practices. Illustrative examples are drawn from a collection of the Building Concepts dynamic interactive documents (available online) designed to support the teaching of mathematics consistent with the Progressions for the Common Core State Standards for Mathematical Content and Practices. Technological Pedagogical Content Knowledge (TPACK) provides a framework for considering how teachers' knowledge must be transformed to best realize the potential of these technologies, and to shape recommendations for professional development and directions for future research."

Dragnic-Cindric, D., Barrow, E., & Anderson, J. L. (2019). Opportunity to start strong: Integration of technology in science lessons in the early elementary grades. In M. Khosrow-Pour (Ed.), *TPACK: Breakthroughs in research and practice* (pp. 290–306). https://doi.org/10.4018/978-1-5225-7918-2.ch014

Abstract: "This chapter investigates challenges faced by educators in the early elementary grades as well as opportunities to transform science education in these critical, early years of schooling. We studied kindergarten teacher's first attempt to integrate one-to-one technology in an inquiry-based science lesson, drawing on works of Randi Engle to analyze the framing of the students and the activity, as well as on the works of Peggy Ertmer and colleagues to investigate barriers encountered in the implementation process. We employed Mishra and Koehler's (2006) Technological Pedagogical Content Knowledge (TPACK) framework to understand the dynamic triad of teacher's pedagogy, content, and technology knowledge, need for successful technology implementation endeavors. While implementations of technology enhanced inquiry-based science lessons in early elementary grades present educators with some unique dilemmas, they also carry a potential for sparking the scientific curiosity of the youngest elementary school learners' and illuminating the years to come."

Edson, A. J., & Thomas, A. (2019). Transforming preservice mathematics teacher knowledge for and with the enacted curriculum: The case of digital instructional materials. In M. Khosrow-Pour (Ed.), *TPACK: Breakthroughs in research and practice* (pp. 96–121). https://doi.org/10.4018/978-1-5225-7918-2.ch005

Abstract: "In a curriculum system, instructional materials and their enactment impacts students learning of school mathematics. In this chapter, the authors re-examine enacted curriculum in light of research on Digital Instructional Materials (DIMs) and the critical role of the mathematics teacher. This chapter documents research from two different studies suggesting that, while effectively leveraging digital materials may require teachers to think outside of their traditional views of how mathematics content is learned and communicated, doing so requires more than the resources themselves. In order to seize upon the potential for DIMs to support student learning in mathematics, teacher preparation must offer opportunities for teachers to develop and transform their technological pedagogical content knowledge (TPACK) knowledge for and with DIMs. To this end, the authors propose specific recommendations for teacher preparation programs in the digital age."

Ekmekci, A., Papakonstantinou, A., Parr, R., & Shah, M. (2019). Teachers' knowledge, beliefs, and perceptions about mathematics teaching: How do they relate to TPACK? In M. L. Niess, H. Gillow-Wiles, & C. Angeli (Eds.), *Handbook of research on TPACK in the digital age* (pp. 1–23). https://doi.org/10.4018/978-1-5225-7001-1.ch001

Abstract: "Providing a study on mathematics teachers' technological pedagogical content knowledge (TPACK), the goal of this chapter is to investigate the predictive value of teachers' beliefs (e.g., self-efficacy) and mathematical knowledge for teaching (MKT) on their level of TPACK. Background variables, gender, ethnicity, certification, experience, and mathematics degree were all controlled for in this study. Two-step regression analysis results by school level (K-5, middle, and high) indicate that standards-based mathematics teaching beliefs positively predict mathematics teachers' level of TPACK for all teachers. Having a college/graduate mathematics degree is more predictive of TPACK for K-5 and middle school teachers while MKT is more predictive of TPACK for high school teachers. In addition, elementary teachers' mathematics self-concept and pedagogical preparedness and middle school teachers' mathematics teaching interest were significantly related to their level of TPACK. The implications for school districts and teacher preparation programs to develop TPACK for teachers are discussed."

Enderson, M. C., & Watson, G. S. (2019). Preparing pre-service STEM teachers to teach using digital modeling and simulation applications. In M. L. Niess, H. Gillow-Wiles, & C. Angeli (Eds.), *Handbook of research on TPACK in the digital age* (pp. 413–436). https://doi.org/10.4018/978-1-5225-7001-1.ch019

Abstract: "This chapter presents a case approach used for modeling and simulation applications in a science, technology, engineering, and mathematics (STEM) teacher preparation program to assist in the development of technological pedagogical content knowledge (TPACK). In this digital age, many pre-service teachers use technological tools daily but do not have knowledge on how to use tools in ways to help develop understanding of STEM concepts. The authors present a framework that promotes learning by teaching to prepare STEM teachers with ways to use modeling and simulation tools in classroom instruction."

Gillow-Wiles, H., & Niess, M. L. (2019). Engaging a workbench dialectic inquiry model in an online master's degree program: TPACK development through communities of inquiry. In M. L. Niess, H. Gillow-Wiles, & C. Angeli (Eds.), *Handbook of research on TPACK in the digital age* (pp. 279–301). https://doi.org/10.4018/978-1-5225-7001-1.ch013

Abstract: "This cross-case descriptive study suggests a model for designing online courses that supports TPACK development through communities of inquiry. Borrowing from the world of science research literature, a workbench dialectic inquiry model was engaged in designing a small group-large group dynamic. Mimicking scientists at the workbench, the participants formed relationships in small groups to develop ideas about TPACK, presented their ideas to the larger, whole-class group, then returned to the small groups to integrate feedback. This dynamic group interaction structure provided the participants with the space to develop their TPACK thinking in ways that supported the transition to cognitive discourse. Analysis of the forum postings revealed the complexity of the participant interaction and suggested that facilitating student community engagement supported the development of their TPACK. Course design details are provided. Further research directions might include applying the workbench dialectic inquiry model in other educational contexts and with larger student populations."

Goodson-Espy, T., & Poling, L. (2019). Interactive whiteboards: Preparing secondary mathematics teachers to avoid Catch-22. In M. Khosrow-Pour (Ed.), *TPACK: Breakthroughs in research and practice* (pp. 401–416). https://doi.org/10.4018/978-1-5225-7918-2.ch019

Abstract: "This chapter examines the literature on the use of Interactive Whiteboards (IWBs) in secondary mathematics instruction and notes barriers and achievements. The chapter links the use of IWBs to models for teaching Technological Pedagogical Content Knowledge (TPACK). Specifically, it proposes ways in which pre-service secondary mathematics teachers can be prepared to use IWBs to help their students develop understanding of critical mathematics ideas while engaging with worthwhile mathematical tasks and engaging in meaningful discourse."

Harlow, D. B., Hansen, A. K., McBeath, J. K., & Leak, A. E. (2018). Teacher education for maker education: Helping teachers develop appropriate PCK for engaging children in educative making. In S. M. Uzzo, S. B. Graves, E. Shay, M. Harford, & R. Thompson (Eds.), *Pedagogical content knowledge in STEM* (pp. 265–280). https://doi.org/10.1007/978-3-319-97475-0_14

Abstract: "Despite the potential of the maker movement to influence how we teach students in school, thus far, most research on maker activities have taken place in informal spaces, such as museums and after-school programs, which are inaccessible to some populations. To ensure maker education reaches *all* students, it must find its place at school. However, classroom-based maker activities have different constraints and may require teachers to hold different types of knowledge. We drew from the body of research on maker education to create a course that prepared pre-service elementary school teachers to implement activities that were

consistent with the maker ethos and met state and district standards. As a course assignment, the teacher candidates designed and hosted a School Maker Faire for elementary school children, providing an opportunity for local children to participate in maker activities and for pre-service elementary school teachers to design, facilitate, and reflect on maker education as a method of teaching science. In this paper, we delineate the constituent parts of maker pedagogical content knowledge and describe how pre-service teachers developed the appropriate knowledge for integrating maker education activities into their classroom curriculum. We propose that the knowledge teachers need to facilitate and assess student learning through maker education is more complex than either science pedagogical content knowledge or engineering pedagogical content knowledge."

Harrington, R. A., Driskell, S. O., Johnston, C. J., Browning, C. A., & Niess, M. L. (2019). Technological pedagogical content knowledge: Preparation and support of mathematics teachers. In M. Khosrow-Pour (Ed.), *TPACK: Breakthroughs in research and practice* (pp. 324–346). https://doi.org/10.4018/978-1-5225-7918-2.ch016

Abstract: "The purpose of this study was to analyze the literature regarding implementation of the Technological Pedagogical Content Knowledge (TPACK) framework in the preparation and support of mathematics teachers. A comprehensive literature review was performed on over a decade of relevant peer-reviewed publications and dissertations since the National Council of Teachers of Mathematics (NCTM) first identified technology as a fundamental principle of good mathematics programs. The results indicate that TPACK has become a foundational framework in the research. Specific studies highlighted in this paper show that, while individual components of TPACK are illustrated in the literature, the field is still lacking sufficient examples of these components acting as a "total package" (Niess, 2008). Programs that develop and support mathematics teachers need more guidance from researchers regarding the best ways to realize the vision of NCTM."

Hunter, J. L. (2019). High possibility classrooms: A new model for technology integration. In M. Khosrow-Pour (Ed.), *TPACK*: *Breakthroughs in research and practice* (pp. 518–547). https://doi.org/10.4018/978-1-5225-7918-2.ch025

Abstract: "This chapter reports on a case study of a high school teacher from a larger study of 'exemplary' teachers and how they conceptualized their knowledge of technology integration in education contexts (Hunter, 2013). The research was a series of purposeful case studies of teachers in classrooms in Australia. The study found that theory, creativity, public learning, life preparation and contextual accommodations are crucial. Each conception of the teachers' knowledge is underpinned by particular pedagogical themes that together form a fresh vision for technology integration known as High Possibility Classrooms or HPC. Kitty, the teacher featured in this chapter, conceptualized her knowledge of technology integration based on flexibility, experiential learning and creativity, preparation of learning, and whole school culture. This case study builds on the TPACK framework (Mishra & Koehler, 2006) and provides an important theoretical and practical exemplar of technology integration in practice for teacher education in a digital age."

Ireri, B. N., Wario, R. D., & Mwingirwa, I. M. (2019). Choosing and adapting a mobile learning model for teacher education. In M. Khosrow-Pour (Ed.), *TPACK: Breakthroughs in research and practice* (pp. 204–220). https://doi.org/10.4018/978-1-5225-7918-2.ch009

Abstract: "Teachers and instructors end up choosing any instructional design and tools for luck of guiding frameworks especially when integrating teaching and learning with mobile technology. The decision by the instructor becomes even more complex when presented with multiple traditional frameworks to choose from. The Technological Pedagogical Content Knowledge (TPACK) model has lately become popular in teacher training, however, research continues to explore on its effectiveness especially in a fast growing technological environment. New models are being created and this chapter has attempted to present such model that can aid teachers and instructors in making a good choice. Content Relevance and Serving, Content Format and Packaging, Learner Attention, Learner Feedback and Context Awareness where factors identified as critical in making a choice for an instructional design model to adopt."

Jaipal-Jamani, K., & Angeli, C. (2018). Developing teacher self-efficacy to teach science and computational thinking with educational robotics: Using scaffolded programming scripts. In C. B. Hodges (Ed.), *Self-efficacy in instructional technology contexts* (pp. 183–203). https://doi.org/10.1007/978-3-319-99858-9_11

Abstract: "There is a paucity of studies examining pre-service teachers' self-efficacy to use robotics to teach science, and especially computational thinking skills. This chapter reports on a study examining pre-service teachers' self-efficacy to teach science and computer programming with robotics using LEGO WeDo robotics kits supported by scaffolded programming scripts. Pre-service teachers' self-efficacy was assessed, before and after the robotics activity, with questionnaires to evaluate the extent to which the scaffolded programming intervention influenced them positively or negatively in believing that they developed the skill and confidence to teach with educational robotics. Statistical results indicate that the robotics intervention with scaffolded programming scripts was successful at increasing pre-service teachers' computational thinking skills and self-efficacy for teaching with robotics. The study results further suggest that the scaffolded programming intervention provides a promising instructional strategy for teaching computational thinking through science design activities with robotics kits."

Kaplon-Schilis, A. A., & Lyublinskaya, I. (2019). Development and transfer of TPACK from pre-service to in-service experience for a special education elementary school teacher: Case study. In M. L. Niess, H. Gillow-Wiles, & C. Angeli (Eds.), *Handbook of research on TPACK in the digital age* (pp. 173–198). https://doi.org/10.4018/978-1-5225-7001-1.ch009

Abstract: "This case study analyzed the TPACK development and a learning trajectory of a single pre-service special education elementary school teacher during TPACK-based graduate pedagogy course and TPACK transfer from this course to the teaching during induction year. The case study was guided by the following research questions: 1) What instructional strategies

and experiences in the graduate pedagogy course supported TPACK development of this pre-service teacher? and 2) What are the internal and external factors affecting TPACK transfer for this teacher? The study showed that TPACK level of the participant increased to exploring level of TPACK throughout the graduate course, but regressed to Adapting level during first year of teaching showing partial transfer of TPACK. The study described course experiences and instructional strategies that supported preservice teacher's TPACK development in the graduate course and identified some external and internal factors that could have affect the transfer of TPACK from college classroom to teaching."

Kokoc, M., & Karal, H. (2019). A study on the technological pedagogical content knowledge experiences of primary school teachers throughout blended professional development programs. In M. L. Niess, H. Gillow-Wiles, & C. Angeli (Eds.), *Handbook of research on TPACK in the digital age* (pp. 302–327). https://doi.org/10.4018/978-1-5225-7001-1.ch014

Abstract: "The purpose of the chapter is to examine the effectiveness of a blended teacher professional development program focused TPACK on the TPACK development of primary school teachers. The study describes a blended teacher professional development program in which primary school teachers developed their TPACK. An embedded experimental mixed method design was employed. A total of 12 events were organized including six face-to-face seminars and six online seminars which were performed by field experts within the program. A Facebook group was created to promote sharing and to increase communication and interaction among the participants. Quantitative results indicated that all participants developed their perceived TPACK knowledge and skills with respect to their subject matter and pedagogical approaches. Qualitative results indicated that the participants reflected knowledge, skills, and actions that met the indicators related to TPACK development. The study has significant implications for the understanding of how design and conduct effective blended program."

Lemanski, L., & Van Deventer, M. M. (2019). A framework for the redesign principles that improve engagement in an online graduate class. In K. Walters, & P. Henry (Eds.), *Fostering multiple levels of engagement in higher education environments* (pp. 49–75). https://doi.org/10.4018/978-1-5225-7470-5.ch003

Abstract: "At a large, Midwest university, the authors taught an online course to graduate students in an educational reading methods course. While the course covered compelling content, the user experience frustrated students as they struggled to navigate an outmoded online learning management system (LMS), which inhibited their ability to engage with course content. Recognizing that the course could be a powerful and relevant learning experience for students, the chapter authors drew on engagement theory, technological pedagogical content knowledge (TPACK), and the triple E framework to redesign the course. While maintaining the valuable course content, the chapter authors developed a framework to create an engaging and positive online learning experience. This chapter describes the framework and details how the

course was redesigned, articulates the rationale for the course changes, and explores the positive impact it had on teaching and learning."

Lovett, J. N., Dick, L. K., McCullough, A. W., Sherman, M. F., Edgington, C., Wanner, C. A., & Reed, S. D. (2019). Eliciting pre-service secondary mathematics teachers' technological pedagogical function knowledge. In M. L. Niess, H. Gillow-Wiles, & C. Angeli (Eds.), *Handbook of research on TPACK in the digital age* (pp. 365–389). https://doi.org/10.4018/978-1-5225-7001-1.ch017

Abstract: "The purpose of this study was to examine the evidence of technological pedagogical function knowledge that preservice secondary mathematics teachers (PSMTs) exhibited through engaging in a module in which they examine artifacts of students' mathematical thinking with technology. Three cases are presented to describe the evidence of technological pedagogical function knowledge that was elicited through engagement with the module. Findings show that the module was successful in eliciting PSMTs' function knowledge, technological function knowledge, and technological pedagogical function knowledge. Differences in the manners in which these knowledges were elicited are discussed and implications for teachers of PSMTs are shared."

Mishra, P., Henriksen, D., & Mehta, R. (2019). Creativity, digitality, and teacher professional development: Unifying research, theory, and practice. In M. Khosrow-Pour (Ed.), *TPACK: Breakthroughs in research and practice* (pp. 123–154). https://doi.org/10.4018/978-1-5225-7918-2.ch006

Abstract: "This article describes the development of a trans-disciplinary framework for creative teaching using technology. In recent years, the authors of this paper (and collaborators) have sought to better understand the role of creativity in educational technology. Our approach seeks to inform theory, research, and practice. In this piece we step back to provide a big-picture view of the process of developing a theoretical framework for creative, transformational teaching with digital technology. We describe the development of our ideas over time, through research projects focused on highly creative teachers and their practices. We describe how we have applied these ideas in teacher education courses devoted to creativity and technology, and developed rubrics for evaluating creative products. At a meta-level we aim to provide a rich example of the reciprocal nature of theory, research, and practice in educational technology. Through this we hope to provide one example of how such a theory/research/practice development process works, with the goal of informing future work of this type."

Morales-Gonzalez, B., Edel-Navarro, R., & Aguirre-Aguilar, G. (2019). The practices of learning assessment in the initial teacher training: A glance from the TPACK model. In M. L. Niess, H. Gillow-Wiles, & C. Angeli (Eds.), *Handbook of research on TPACK in the digital age* (pp. 113–130). https://doi.org/10.4018/978-1-5225-7001-1.ch006

Abstract: "The purpose of the chapter is to disseminate a comparative study developed in an institution dedicated to teacher training in the state of Veracruz, Mexico. The study led the follow-up of two teachers responsible for a course of bachelor's degree in Preschool Education called Learning Environments during a semester. Three interviews were applied to two participating teachers. Through inductive analysis, MaxQDA software was chosen to identify categories of analysis. The work is analyzed from the TPACK model, as a systemic and integral proposal to investigate teacher training practices as a complex and necessary phenomenon to continue studying."

Nicolete, P. C., Bento da Silva, J., Cristiano, M. A., Bilessimo, S. M., Ferreira de Farias, G., & Filho, S. S. (2019). A remote mobile experiment in Brazilian public basic education. In M. Khosrow-Pour (Ed.), *TPACK: Breakthroughs in research and practice* (pp. 457–478). https://doi.org/10.4018/978-1-5225-7918-2.ch022

Abstract: "The STEM subjects (Science, Technology, Engineering, and Mathematics) are very important for education, but the lack of experimental laboratories for these subjects in a school might decrease the interest of its students in STEM fields. This chapter explores these issues in the Brazilian context where, in order to address this issue, remote experiments are used to share real experiments manipulated through the Internet. Teachers and students can use remote laboratories, equipped with real experiments, to put in practice theoretical concepts learned in class. This chapter presents a report on a pilot project that aims to explore the use of Mobile Remote Experimentation (MRE) by teachers and students of public high schools in Brazil. It involves the use of mobile devices to access remote experiments in STEM subjects through the Internet. The report demonstrates the effectiveness of using such educational resources to improve pedagogical results by applying the TPACK (Technological Pedagogical Content Knowledge) model to measure the impact of MRE by STEM teachers."

Niess, M. L., & Gillow-Wiles, H. (2019). Online instructional strategies for enhancing teachers' TPACK: Experiences, discourse, and critical reflection. In M. L. Niess, H. Gillow-Wiles, & C. Angeli (Eds.), *Handbook of research on TPACK in the digital age* (pp. 257–278). https://doi.org/10.4018/978-1-5225-7001-1.ch012

Abstract: "This chapter provides a rich description of how scaffolding discourse and critical reflection with K-12 in-service teachers' online learning experiences enhanced their technological pedagogical content knowledge (TPACK) for teaching with technologies. The experiences modeled learning through inquiry tasks that merged content, technology, and pedagogy as envisioned in TPACK. The participants connected with the experiences as students learning about and with digital image and video technologies. Reflections on the experiences as teachers combined with the discourse interactions among the communities to influence their resulting individual critical reflections. A major theme was the recognition of the importance of shared knowledge as expanding individual knowledge. Four TPACK components revealed that the collection of the experiences, discourse, and critical reflection enhanced the participants' TPACK leading to recommendations for the design of online in-service teacher learning experiences for enhancing teachers' TPACK."

Polly, D. (2019). Developing TPACK for elementary education teacher candidates in an institutional design and technology integration course. In M. L. Niess, H. Gillow-Wiles, & C. Angeli (Eds.), *Handbook of research on TPACK in the digital age* (pp. 329–349). https://doi.org/10.4018/978-1-5225-7001-1.ch015

Abstract: "This chapter examines how experiences in a course for elementary education teacher candidates supported their technological pedagogical content knowledge (TPACK). Based on data from teacher candidates and school partners, the author modified course activities and collected data to inform the course. Data analyses indicated that the course refinements positively influenced candidates' development of aspects of TPACK, specifically TPK, PCK, and TPACK. Candidates reported in both iterations of the study that technology was being used in classrooms in ways that did not match what they were learning in courses. Implications include the need to reconcile the divide between research-based instances of technology integration and the actual use of technology in schools in the context of TPACK."

Read, M. F., Morel, G. M., Butcher, T., Jensen, A. E., & Lang, J. M. (2019). Developing TPACK understanding through experiential faculty development. In M. L. Niess, H. Gillow-Wiles, & C. Angeli (Eds.), *Handbook of research on TPACK in the digital age* (pp. 224–256). https://doi.org/10.4018/978-1-5225-7001-1.ch011

Abstract: "The purpose of this chapter was to explore changes in faculty knowledge, beliefs, and attitudes regarding online teaching and learning, as well as faculty's degree of confidence in developing and implementing online courses after participating in a multiweek, experientially based faculty development program. The study draws on change theory, specifically teacher change in knowledge, beliefs and attitudes, self-efficacy, and the TPACK framework. The findings suggest that faculty development that incorporates elements of collaboration, modeling, peer review, coaching, extended time, and numerous opportunities for observation and reflection are key to participants' TPACK development and positive changes in teaching beliefs, e-learning attitudes, and self-efficacy."

Ringstaff, C., & Haymore Sandholtz (2018). From budgets to bus schedules: Contextual barriers and support for science instruction in elementary schools. In S. M. Uzzo, S. B. Graves, E. Shay, M. Harford, & R. Thompson (Eds.), *Pedagogical content knowledge in STEM* (pp. 67–82). https://doi.org/10.1007/978-3-319-97475-0_4

Abstract: "Improvements in teachers' pedagogical content knowledge are critical in improving science education but may be insufficient to support and sustain instructional changes. This chapter describes how contextual factors influenced teachers' use of research-based instructional strategies learned in professional development. The research draws on survey, observational, and interview data collected from 135 teachers who participated in four different intensive professional development programs that were situated in small, rural school districts with high-need student populations and that extended over 3 years. Each program had a slightly different STEM focus, but all four programs aimed to improve teachers' pedagogical

content knowledge in science and to foster their use of research-based instructional strategies in science. Across programs, teachers' science content knowledge, pedagogical content knowledge, and self-efficacy increased over the course of the professional development. Overall, teachers more frequently used research-based practices for teaching science. But contextual factors varied substantially across schools and districts and both fostered and hindered teachers' science instruction. The most influential contextual factors included time for planning and collaboration, time for science instruction, administrator support, access to resources, and regional constraints. Identifying the contextual factors that influence teachers' use of pedagogical content knowledge gained through professional development is the first step for formulating strategies for supporting and sustaining teacher change."

Ritzhaupt, A. D., Poling, N., Frey, C., Kang, Y., & Johnson, M. C. (2019). A phenomenological study of games, simulations, and virtual environments courses: What are we teaching and how? In M. Khosrow-Pour (Ed.), *TPACK: Breakthroughs in research and practice* (pp. 501–517). https://doi.org/10.4018/978-1-5225-7918-2.ch024

Abstract: "Educational technology programs from across the United States are offering graduate courses in games, simulations, and virtual environments (GSVE) to their students. However, these courses, until now, have not been systematically studied. This research uses a hermeneutical phenomenological approach to answer the research question: "How do instructors describe their experience teaching GSVE courses?" Five professors of educational technology that have taught GSVE courses were interviewed using a semi-structured protocol based on the TPACK (Technological Pedagogical Content Knowledge) framework. These data were analyzed both analytically and thematically. The results of the study showed a wide variety of topics, tools, and pedagogies are used within GSVE courses. The results had five themes emerge: Focus on Application and Theory, Experiential Learning and Constructivism, Instructor's Prior Experience with Games, Heterogeneous Student Populations, and Range of Technology Tools. These themes as well as these courses are highlighted within this paper. A discussion is provided."

Smits, A., Voogt, J., & van Velze, L. (2019). The development of technology integration in a graduate course for practicing teachers. In M. L. Niess, H. Gillow-Wiles, & C. Angeli (Eds.), *Handbook of research on TPACK in the digital age* (pp. 92–112). https://doi.org/10.4018/978-1-5225-7001-1.ch005

Abstract: "This chapter describes the design and outcomes of a graduate course for practicing teachers that aims to develop the quality of technology integration in their educational contexts. The course is rooted in a set of concepts and theories and in three pedagogical principles for enhancing teachers' technology integration. The outcomes of the course were measured by using a mixed methods design. After the course, all students showed satisfactory TPACK scores and most students (83%) produced lessons that showed a good quality of technology integration, and 75% of the lessons showed a rich array of technological affordances. Neither the quality of the technology integration as shown in their lesson design and enactment nor the number of different technological affordances students showed in their

(enacted) lesson design were related to students' TPACK scores after the course. This unexpected finding is discussed. Students reported a development from unconscious technology integration to conscious technology integration."

Sprague, D. S., & Katradis, M. (2019). The transference between elementary preservice teachers' courses and technology use in teaching. In Information Resources Management Association (Ed.), *Pre-service and in-service teacher education: Concepts, methodologies, tools, and applications* (pp. 1459–1489). https://doi.org/10.4018/978-1-5225-7305-0.ch068

Abstract: "This mixed-method study explored a cohort of 18 preservice elementary teachers' perceptions of technology and their abilities to integrate technology in their teaching. Data sources included blog postings, a confidence survey, lessons plans and observations. Results showed a disconnect between the blog postings and confidence survey (their perceptions) and their lessons plans and observations (their abilities). Five case studies were examined, using the TPACK framework, to determine where the disconnect was occurring. Although Technical Knowledge seemed to be an issue for some, the majority of the preservice teachers struggled with Pedagogical Knowledge. Suggestions for how to address this issue are included. Implications for teacher education are discussed."

Suh, J. M., Sprague, D. R., & Baker, C. K. (2019). Transforming mathematics teacher knowledge in the digital age through iterative design of course-based projects. In M. Khosrow-Pour (Ed.), *TPACK: Breakthroughs in research and practice* (pp. 347–371). https://doi.org/10.4018/978-1-5225-7918-2.ch017

Abstract: "This research in this chapter highlights a self-study of three university faculty members who were aimed at improving the design of an Elementary Mathematics Technology Integration Course (EMTIC). The self-study used the faculty unique research lenses and expertise in mathematics education and educational technology to redesign the performance based assignments to better prepare the teacher candidates to integrate technology into their mathematics teaching. This collaboration required faculty members to: 1) Reflect on their beliefs about technology integration; 2) Evaluate their current teaching practices; and 3) Adapt the design of their course assignments to better meet the skills required of teachers and students in the 21st century."

Thomas, A., & Trainin, G. (2019). Creating laboratories of practice for developing preservice elementary teachers' TPACK: A programmatic approach. In M. L. Niess, H. Gillow-Wiles, & C. Angeli (Eds.), *Handbook of research on TPACK in the digital age* (pp. 155–172). https://doi.org/10.4018/978-1-5225-7001-1.ch008

Abstract: "This case study outlines the components and outcomes of a program-wide approach to transforming elementary pre-service teachers' technological pedagogical content knowledge (TPACK). The approach emphasized the creation of laboratories of practice in which pre-service teachers learned about and enacted technology for teaching and learning. Pre-service teachers

developed TPACK through carefully designed and scaffolded learning experiences in technology and content methods coursework, internship experiences, and student teaching. The case offers descriptions and outcomes within a mathematics methods course and across eleven cohorts of student teachers. TPACK survey results at the beginning and end of one course of the program, and measures of TPACK-efficacy and frequency of technology integration at the end of the program indicate that the programmatic approach led to TPACK growth among pre-service teachers."

Wan, A., & Ivy, J. (2019). Adding a new dimension to teaching mathematics educators. In M. L. Niess, H. Gillow-Wiles, & C. Angeli (Eds.), *Handbook of research on TPACK in the digital age* (pp. 390–412). https://doi.org/10.4018/978-1-5225-7001-1.ch018

Abstract: "Technology has the potential to transform the classroom, build access to new mathematical content, and provide access to students through unique representations. For this study, the authors considered the transformational promise of digital fabrication technology, specifically 3D printing, in a setting comprised of pre-service teachers. An introduction to digital fabrication session was implemented in a secondary mathematics methods course. Participants were assessed both prior to the experience and after, using an adapted TPACK developmental self-report survey to consider TPACK themes and subthemes. In this chapter, the authors describe ideas that emerged from narratives provided by participants, patterns of change noted from pre- to post-assessment, and three cases that emerged representing students who experienced the most positive changes, most negative changes, and least amount of change on self-perceived levels."

Weng, W., & Feng, L. (2019). Technology standards for Chinese language teacher education. In M. Khosrow-Pour (Ed.), *TPACK: Breakthroughs in research and practice* (pp. 256–272). https://doi.org/10.4018/978-1-5225-7918-2.ch012

Abstract: "Guided by the TPACK theory (Mishra & Koehler, 2006), this chapter reviews and compares the technology standards related to and designed for teachers of Chinese as a Foreign Language (CFL) from the entry level to the accomplished level in the United States and China. It has found that the technology standards are often included in the comprehensive standards for teachers and parallel the standards about other aspects of teaching. The technology standards related to CFL in the two countries share some similarities but also differ in important ways. Several important and critical understandings are identified, including the needs for CFL technology standards, the theoretical foundations for CFL technology standards, and a more solid and comprehensive infrastructure for CFL education. Recommendations are made to address the needs, and research is called for to study the development and implementation of CFL technology standards."

Wilton, L., & Brett, C. (2019). Beyond apps in pre-service education: Unpacking perceptions of TPACK and global competencies. In M. L. Niess, H. Gillow-Wiles, & C. Angeli (Eds.), *Handbook of research on TPACK in the digital age* (pp. 69–91). https://doi.org/10.4018/978-1-5225-7001-1.ch004

Abstract: "This chapter presents a multiyear case study in a two-year graduate teacher education program at a large urban university in Canada. This research studies how the incorporation of the TPACK theoretical framework and the concept of global competencies supports pre-service candidates' depth of pedagogical understandings when integrating technology into teaching practice. Online surveys were conducted with students attending a compulsory information and communications technology (ICT) course. Five instances of the course across a four-year time span were studied. Online questionnaires were also given to students and five instructors. Four themes were identified by students and instructors: (1) TPACK helps students integrate the three kinds of knowledge, (2) TPACK allows a focus on pedagogy by defocusing on technology, (3) TPACK is a robust theory, and (4) TPACK takes time to integrate into practice. This chapter offers teacher education program recommendations and suggests directions for future research."

Yu, P. W. D., & Golden, J. (2019). Developing TPACK in elementary mathematics education: A framework to design activities with pre-service teachers. In M. L. Niess, H. Gillow-Wiles, & C. Angeli (Eds.), *Handbook of research on TPACK in the digital age* (pp. 47–68). https://doi.org/10.4018/978-1-5225-7001-1.ch003

Abstract: "Two case stories are given of how technological pedagogical content knowledge (TPACK) is developed in a first semester undergraduate pre-service elementary mathematics education course. The theoretical frameworks that guided the design and implementation of technology-based mathematics lessons are discussed, including both TPACK and the substitution, augmentation, modification, redefinition (SAMR) framework. Then the authors describe specific activities intended to develop TPACK, the motivation and implementation for these activities, and excerpts of pre-service teachers' survey results, comments, and reflections about learning elementary mathematics in these courses. The contrast between the courses is focused technology use during one unit with opportunity to teach elementary lessons with the same technology, and pervasive use of technology throughout the other but no opportunity to use the technology with elementary learners. The chapter concludes with a discussion of the implications and issues that have presented themselves in this action research experience."

3. Recent TPACK-Related Dissertations and Theses

Blackford, J. (2018). *Increasing collaboration, shared values, and authentic teaching practices through technological professional development* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 10976690)

Abstract: "The purpose of this outcome-based program evaluation project study was to investigate how professional development (PD) influenced the shared values of 25 district teachers regarding instructional technology and their collaboration and instructional practices using instructional technology. Inclusion criteria included (a) participants had to be 18 years or older and (b) participants had to be a certified teacher. Guided by Mishra and Koehler's TPACK

theory and Guskey's model for PD evaluation, the research was designed to determine (a) how teachers demonstrate collaboration using instructional technology as a result of PD, (b) what shared values teachers have adopted regarding instructional technology as a result of PD, and (c) how the authentic teaching practices of participants have changed because of the technology PD. Data were collected through Likert surveys, interviews, and classroom observations. Data analysis included descriptive statistics for the quantitative portion, and identification of emerging themes for the qualitative portion. The results reflected ways technology is being implemented into instructional strategies. The implication of this study for social change includes support for including collaboration and shared values in professional development to improve instructional strategies incorporating technology, which can lead to improved learning environments. Teachers and the school can benefit by having the knowledge of how technology and PD provided by the OETT grant enhanced instruction. Social changes that may occur due to the findings of this study include the school gaining a better understanding of the influence of technology in instruction on student learning and identifying tools that potentially increased teacher uses of the technologies purchased as well as teacher application of the knowledge gained in the PD provided through the grant."

Brockhausen, C. M. (2018). *The development of teacher knowledge of teaching multimodal argument to students with learning disabilities* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 10937760)

Abstract: "The purpose of this qualitative case study was to understand how an English Language Arts (ELA) teacher of 7th and 8th grade students with language-based learning disabilities attempted to learn about and integrate into her instructional practice the teaching of argumentative writing using multimodal technologies. The ELA teacher's attempt at learning and integrating this new methodology into her instructional practice occurred during and subsequent to an in-service professional development program. Multiple data sources, including interview transcripts of meetings with the teacher, observation field notes, and lesson plan documents were analyzed using the technological, pedagogical and content knowledge (TPACK) framework and discourse analysis. Unexpectedly, there was very little change in the teacher's beliefs and attitudes about technology after learning about this multimodal method to teach argumentative writing. Thus, the teaching of this new methodology through in-service professional training was not integrated into her ELA classroom practice. This finding illuminates the uncertainties involved in the role of professional development in the integration and execution of new methods of teaching. This understanding could enable the development of alternative in-service professional development techniques and interventions that could shape ELA classroom instructional expertise and practice."

Carroll, K. D. (2018). *The transition from traditional to virtual platform in the military school system* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database (UMI No. 10790955)

Abstract: "The purpose of this qualitative single case study was to examine the experiences of instructors and school leaders as they transformed a 2-week program managers' residential

classroom course into 5 virtual synchronous classroom courses in the U.S. Army School for Family, Morale, Welfare, and Recreation system. Three research questions pertaining to the participants' experiences, as well as technological and pedagogical needs, were posed to achieve the study objectives. The theoretical framework guiding the study combined theories on holistic learning, facilitation, and andragogy. For this single intrinsic case study, semi-structured interviews and document analysis were conducted with 24 participants who were instructors and school leaders tasked with online curriculum development. Data were analyzed, coded, and categorized into themes. Findings revealed change(s) experienced by instructors, such as program processes, instruction, assessment, and learner support. These changes functioned in combination with the technical difficulties, such as connectivity and firewall issues, to provide insight into the nature of the technical abilities and skills needed for traditional to virtual course transformation. Skills and abilities needed for such a transformation included subject and technological knowledge together with pedagogical or andragogical knowledge. Practical implications pointed toward the requisite efforts of redefining teaching roles, developing new attributes, and acclimating to the online environment. To achieve these goals, certified professional development or pre-service online-teaching courses, programs, and ongoing repetition of technological skills were needed. Essentially knowing what one taught and knowing how to teach were of primary concern and of highest value. Recommendations included (a) engaging in online teaching-specific and application-specific professional development, (b) promoting and ensuring quality instruction, and (c) compensating for added teacher workload."

Fox, A. (2018). *Middle school teachers' technology integration* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 1095763)

Abstract: "Although school districts have invested heavily in technology for teachers and students, the problem of inconsistent technology integration permeated a local school district. In order to create a 21st century learning environment for students, teachers must integrate technology with curriculum and evidence-based teaching practices. The purpose of this case study was to investigate current middle school teachers' technology integration in a suburban school district in North Dakota, Midwest Public Schools (pseudonym). Technological Pedagogical Content Knowledge (TPACK) was used as a conceptual framework to guide the study. This study focused on exploration of current teacher practice in regard to technology integration and the perceived support they currently receive to do so. A case study research design was used, and data collection included interviews and classroom observations of 10 middle school teachers to determine current technology integration practices and explore the barriers for integration and teachers' perceived support in this endeavor. The 10 participants were chosen based on content area, grade level, and years of experience. The data were analyzed using thematic coding followed by an open coding process based on the TPACK framework constructs. Teachers are using technology in their instruction at varying levels. Overall, the case showed a strong indication of TCK and lower results in the area of student technology use. The results provided information for administrators in the district regarding additional training for teachers based on their current technology integration and perceived barriers of implementation in the classroom. Social change implications for this study involve an

increased awareness of technology integration for teachers and administrators. Classroom teachers in this local district as well as districts across the nation could benefit from improved practice using technology to be able to learn and work in the complex school and work environments."

Frier, A. (2018). *Beyond replicative technology: The digital practices of students with literacy-related learning difficulties engaged in productive technologies* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 10840086)

Abstract: "In this dissertation, I present the findings from a qualitative case study of the digital literacy integration of a teacher and the digital literacy practices of three students with literacy-related learning difficulties within her classroom. As a researcher, I was interested in the ways students with literacy- related learning difficulties navigated digital tools in a technology-infused environment created by a teacher who has experience using digital tools for instructional and student-learning purposes. My research was guided by the following questions: (1) What was the context, content, and structure of the teacher's technology instruction? (2) In what ways did the students use technological tools? (3) How did students with reading difficulties compose during digital literacy events? The data for this case study included classroom observations, interviews, field notes, work samples, and lesson plans. Through the use of both inductive (Phase I and II) and a priori (Phase III) analysis, the data highlight several important findings to inform the research questions: (a) Knowledge of Technology Does Not Ensure Technological Pedagogical Content Knowledge (b) Students with Reading Difficulties Still Have Difficulty with Reading Despite Technology Integration and (c) Change in Writing Tool (technology) does not Guarantee Change in Writing Performance."

Hall, J. (2018). *Comparison of the first principles of instruction in flipped and face-to-face technology integration courses* (Doctoral dissertation). Retrieved from https://surface.syr.edu/etd/918

Abstract: "This dissertation examines the impact of the First Principles of Instruction (FPI) model when applied to face-to-face (F2F) and flipped technology integration courses. Through this investigation, I demonstrate how the FPI inform the design of problem-centered environments, their impact on participants' technological, pedagogical, content knowledge (TPACK), and the essential aspects of experiencing these FPI-based courses. Using an embedded quasi-experimental mixed methods design, the quantitative analyses of pre-and post-TPACK outcomes were examined and related to the interventions' mechanisms via the descriptive phenomenological analysis of participants' course learning experiences. Participants were 32 preservice teachers enrolled in the second of three required technology integration courses during the 2017 spring and fall semesters. Data included surveys, technology-integrated lesson designs, prompted course reflections, and semi-structured interviews.

In the flipped group, preservice teachers' self-perceptions of TK, PK, TCK, TPK, and TPACK statistically significantly increased and had large effect sizes. Except for TK, the F2F group's self-perceptions of all TPACK domains statistically significantly increased with medium to large effect sizes. The non-significant growth in the F2F group's TK, an unexpected outcome

of a technology integration course, was illuminated by the qualitative analysis. Participants' experiences unique to the flipped section indicated that exposure to new technologies prior to the physical class contributed to their increased perception of TK. As for application of TPACK to technology-integrated lesson designs, both groups demonstrated statistically significant growth with large effect sizes (F2F p= .000, d= 1.17; Flippedap= .000, d= 1.97). The magnitude of the results strongly demonstrates the FPI's positive impact on TPACK-related learning outcomes in the F2F and flipped courses. Further analysis revealed no statistically significant differences between groups' perceptions and application of TPACK. These non-significant differences suggest the FPI were equally effective when applied to designing flipped and F2F courses. The phenomenological analyses revealed that the participants experienced technology integration often in class and noted the importance of purposefully selecting and using technologies. Participants described learning new technologies in the course as proceeding from practicing technological skills to evaluating digital tools' potential for future integration. While iterative component tasks were experienced by some as redundant, participants valued the problem progression corollary's task variation and scaffolded nature for focusing their learning and keeping them confident when challenged. Experiencing incongruous moments between design and implementation prompted participants' contemplations of persisting barriers to technology integration and appraisals of in-class experiences as designed for the ideal. The FPI-based elements experienced by participants, when viewed through the perspective of constructionism, facilitated preservice teachers' TPACK construction as they designed and shared tangible artifacts with an authentic audience. The study's implications endeavor to inform future approaches to technology integration preparation, directions for FPI-based research and design, and the development of TPACK measures."

Hammett, V. L. (2018). *Faculty integrating technology into higher education courses: A quantitative analysis* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 10933524)

Abstract: "Faculty Integrating Technology into Higher Education Courses: A Quantitative Analysis (August 2018) Victoria L. Hammett, B.S., North Carolina A&T State University; M.S., North Carolina A&T State University; Chair of Advisory Committee: Dr. Martha Jallim-Hall Research has focused on faculty's preparation and expertise that is vital to successfully integrating technology into courses (Mishra & Koehler 2006). The purpose of this quantitative study was to determine which aspect faculty members are utilizing when integrating technology into courses in higher education. The research questions that guided this study are the following: (1) Do differences exist between gender and HE-TPACK? (2) Does a relationship exist between academic ranking and HE-TPACK? (3) Does a relationship exist between tenure status and HE-TPACK? (4) Does a relationship exist between teaching experience and HE-TPACK? (5) Does a relationship exist between technology training and HE-TPACK?

An electronic minimally modified version of HE-TPACK survey was collected from 132 full-time faculty members. *t*-Test and One-Way Analysis of Variance (ANOVA) were used to analyze data regarding faculty's integration of technology into their courses using the HE-TPACK framework. Using *t*-Test it was found that there are no statistically significant differences when it comes to HE-TPACK values and gender. The research also uncovered using ANOVA to analyze

results that there is no significant difference among technology training. However, when using ANOVA to analyze ranking, tenure status, and years of experience there were statistical differences in the data. The results of this research indicated that integrating technology in higher education courses are based on ranking, tenure status, and years of experience with the university, and has less to do with faculty's gender or number of technology trainings they have attended. Recommendations for future research included conducting a qualitative study, longitudinal studies, and addressing barriers faculty are faced with when integrating technology into courses. In conclusion, this information can be used to help senior leaders and administrators recognize opportunities in faculty development, which may lead to creating innovative solutions that in turn provide professors with the tools needed to cultivate positive student outcomes."

Hruska, J. D. (2018). *Investigating faculty perceptions of technological, pedagogical, and content knowledge (TPaCK) at a newly established university* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 10748716)

Abstract: "This dissertation is in response to Garrett's (2014) dissertation on *"A Quantitative Study of Higher Education Faculty Self-Assessments of Technological, Pedagogical, and Content Knowledge (TPaCK) and Technology Training"* which has been the inspiration and guide throughout the design of this study. The purpose is to assess the perceptions of tenure and non-tenure faculty on technological, pedagogical, and content knowledge (TPaCK) at a recently established university in Texas. More specifically, this study compared and contrasted the technological, pedagogical, and content knowledge (TPaCK) of faculty use of technology tools in face-to-face, blended learning and online environments as methods to enhance learning based on academic college, academic ranking, academic status, years of experience and gender.

This quantitative study uses the HE-TPaCK survey developed by Garrett (2014) to collect and analyze data around technological, pedagogical, and content knowledge using descriptive statistics and multiple regression analysis. The results showed a significant difference ($p < .007$) in academic college and academic status in the domain of pedagogy knowledge (PK) and technology pedagogy knowledge (TPK). Overall, the results provide implications to drive future professional development at the university, adds to the discourse around the conceptual framework of TPaCK as well as validate the use of the HE-TPaCK instrument. In addition to implications for the institution and research, this work provides insight to policy makers in regards to incentives and institutional support that would promote the use of technology for the purpose of instruction."

Janezic, L. (2018). *Middle school teachers' use of iPads to support disciplinary literacy practice in the social studies classroom* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 10839902)

Abstract: "This case study examined how middle school teachers combined technological, pedagogical, and content area knowledge together with a 1:1 iPad initiative to implement a disciplinary literacy approach to teaching social studies. Six teachers in a far northwest suburb of Chicago took part in text-based verbal protocol and standard interviews, allowed classroom

observations, and completed self-report surveys as part of the data collection process. Data revealed that although the teachers did not recognize the term disciplinary literacy, they did incorporate these principles and practices into their classroom instruction. Although teachers identified content as more important in lesson planning over technology and pedagogy, the iPad was identified as a necessary tool for communication and sharing content and resources with students during and outside of instructional classroom time. The results of this study concluded with a model that provided a visual representation of the three interrelated constructs necessary for successful implementation of disciplinary literacy in the 21st century: inquiry-based curriculum, disciplinary literacy standards and practices, and district-supported technology. It was suggested that future research address a more in-depth look into teaching with disciplinary literacy in mind, and how teachers' decision making with technology, pedagogical, and content knowledge impact instructional practices in the social studies classroom."

Kaplon-Schilis, A. (2018). *Development and transfer of technological pedagogical content knowledge (TPACK) of special education teachers* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 10934201)

Abstract: "This dissertation presents findings of three studies investigating the development and transfer of TPACK of pre-service and in-service elementary school special education teachers. The dissertation is presented in a non-traditional format including an introduction, three manuscripts submitted for journal publication, and a summary chapter. The purpose of the first study was to analyze development of TPACK of pre-service elementary special education teachers enrolled in a graduate level pedagogy course *Integrating Technology in Mathematics and Science Instruction in Special Education and Inclusive Classrooms* in a New York City public college. The study's research question was to find out whether the TPACK-based course affects TPACK and basic TPACK domains of pre-service special education teachers' knowledge: TK–technological knowledge, PK–pedagogical knowledge, and CK–content knowledge. The paired sample t-test indicated significant gains in teachers' TPACK, however there were no significant changes in PK, TK and CK. The first study raised questions of whether the TPACK basic domains are independent of the TPACK domain. The purpose of the second study was to investigate the question raised in the first study i.e., whether TK, PK, and CK are independent constructs in the TPACK framework and to develop instruments for assessing the basic domains of the TPACK. Exploratory and confirmatory factor analyses suggested that the TPACK construct is independent from TK, PK, and CK. Multiple linear regression showed that TK, PK and CK are not predictors of the TPACK for this population. The purpose of the third study was to analyze TPACK development and a learning trajectory of a single pre-service elementary special education teacher and TPACK transfer from this course to the teaching during the induction to teaching year. It was noted that the graduate pedagogy course played a critical role in developing pre-service teacher's TPACK. The study suggested several internal (teacher's attitude towards using technology and preparedness–teacher's comfort with using technology) and external (access to technology and school support) factors affecting transfer of teacher's TPACK from her pre-service to in-service teaching experience."

Price, E. Y. (2018). *Exploring teachers' perceptions of professional development for a blended learning environment: A qualitative case study* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 10934226)

Abstract: "Blended learning is gaining momentum in K-12 schools, and teachers are required to make a paradigm shift in instructional practices geared to the online learning environment but are unprepared for the unique pedagogical skills. The problem addressed in this qualitative case study was K-5 teachers' professional development is inadequate for the paradigm shift of teaching in a blended learning environment. The purpose was to explore teachers' perceptions of received professional development designed to prepare them for the paradigm shift of teaching in a blended learning environment. The theoretical framework guiding this qualitative case study were constructivism and the TPACK. Both theories share a common bond in that teachers are using 21st-century skills in applying appropriate technological and pedagogical skills in a learner-centered environment to support the current curricula. Data were electronically collected from five K-5 teachers using an online questionnaire and documentary analysis. Member checking was conducted multiple times to ensure researcher accurately presented participants' viewpoint. After the coding of data in HyperResearch 4.0, four themes emerged in answering both research questions. The themes were, first, professional development experiences of K-5 teachers; second, pedagogical blended strategies of K-5 teachers; third, technical skills of K-5 teachers; and fourth, modification of K-5 teachers' belief systems. The findings revealed that after two-three years of participating in professional development activities, teachers felt as if they were adequately prepared for the paradigm shift of transitioning to a blended learning environment but 80% lacked knowledge in pedagogical skills designed for the online learning environment. Future recommendations are to use an evaluation tool for teachers to self-assess their beliefs and design professional development activities solely to address online pedagogy."

Raper, R. C. (2018). *The relationship between secondary teachers' technological pedagogical content knowledge and technology integration factors* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 13422418)

Abstract: "Research in educational technology has led to the discovery of factors for successful technology integration into the classroom—technology access and support, professional development, attitudes toward technology, technology use by students, and technology use by teachers. Additionally, using the Technological Pedagogical Content Knowledge (TPACK) theoretical framework, a teacher's understanding of the knowledge required to effectively implement technology can be measured. This study attempted to examine the relationship between teachers' TPACK score and the key indicators of technology integration using the TPACK survey and the Survey of Technology Integration and Related Factors (STIR). Using a nonexperimental, correlational design, participants were selected from a population of secondary teachers at two school systems in East Tennessee who use the learning management system (LMS) Blackboard. The total sample size was 129 participants. Data were analyzed using a canonical correlation to examine relationships. Results of the survey indicated that a statistically significant relationship exists between a teacher's TPACK score and the five factors

of technology integration, with general technology usage by the teacher, teacher attitudes toward technology, and professional development having the largest effects. Further research should be conducted on differing populations, populations that do not use Blackboard LMS, and other integration variables. Furthermore, studies that include teaching experience as a covariate or longitudinal studies regarding TPACK and technology integration factors should be researched."

Swinton, A. M. C. (2018). *World language teacher education and web-enhanced language learning (WELL): How k-12 world language teachers learn to effectively use (WELL) technologies in the classroom* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 10837442)

Abstract: "The purpose of this mixed methods study was to find out the ways in which web enhanced language learning (WELL) technologies are learned that make them more likely to be effectively integrated into the K-12 classroom. Specifically, the study investigated characteristics of WELL teacher training that translate to effective classroom implementation. The theoretical and conceptual frameworks used were Mishra and Koehler's (2006) Technological Pedagogical Content Knowledge (TPACK) and the Teachers of English as a Second Language (TESOL) Technology Standards (2008). Both quantitative and qualitative data were gathered from surveys, interviews, and observations of K-12 world language teachers in North Carolina. This study integrated quantitative and qualitative data in a convergent sequential design. Descriptive statistics and Pearson's Chi Square goodness of fit tests were used to analyze the quantifiable responses on the survey and thematic coding was used for the open responses. Thematic coding and categorization were used to analyze the interview and observation data.

The findings of the study revealed teachers mostly learned to use WELL technologies by themselves, with colleagues, through teacher education activities and through online sources. Additionally, they stated that effective WELL teacher education activities are interactive, allow for practice time and help teachers preemptively troubleshoot potential problems. Teachers applied their WELL teacher education by using TESOL (2008) defined effective practices in classroom. They used WELL technologies to provide individualized practice, increase student motivation, to engage students into language learning, and provide access to authentic resources. Although teachers learned to use WELL technologies in a variety of ways, they used effective practices to integrate what they had learned into the curriculum. Nonetheless, they still desired increased access to more effective teacher education activities that could aid them in continuing to be knowledgeable practitioners of technology in world language classrooms. This study provided several implications for how teacher educators should conduct training activities, how teacher education programs can support pre-service teachers, and how school districts can support in-service teachers."

Unten, T. D. B. (2018). *Community college online math instructors' perceptions of the TPACK framework* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 10936044)

Abstract: "Community college online mathematics courses have the highest course attrition rates among all subject matters and degree levels. The problem could be addressed through professional development and assessment tools generated with the core foundations of TPACK framework - integrated knowledge between technology, pedagogy, and content. Using the hermeneutic qualitative phenomenological approach, this researcher explored community college online mathematics instructors lived experiences with professional development and assessment tools and their perceptions on utilizing TPACK to improve course attrition rates. Data collection in this study resulted in the identification three main textual themes for professional development and assessments: (1-1) Internal Resources, (1-2) Student Feedback, and (1-3) External Resources. For reasons to accept the TPACK framework, two main textual themes were identified: (1a-1) Motivation to Learn and (1a-2) Self-Concept as the emergent themes. For reasons to reject the TPACK framework, three main textual themes were identified: (1b-1) Time and Effort, (1b-2) Complacency, and (1b-3) Effectiveness Questioned as the emergent themes. As for implementation barriers, (1c-1) Administrators' Influence, (1c-2) Faculty Observation, and (1c-3) Perception of Teaching Online Math Classes were identified as the three main textual themes. For the ideal conceptual framework, three main textual themes were identified: (2-1) High Impact Interactivities, (2-2) Technology Guidelines, and (2-3) Long-Term Goals. Based on the results, the researcher recommends that academic leaders support the instructors with growth mindsets in their endeavors, and provide short-term solutions utilizing the TPACK framework for all others. The researcher also recommended the following focal points for further discussions: (a) expanding the current training and support services for instructors and students with internal resources, (b) the resistant culture or misconceptions among instructors and administrators, and (c) the need for awareness of technology guidelines, best practices, and resources available to create high impact interactivities for online math instructors. Based on the limitations and findings of this study, the following recommendations are offered as directions for future research: (a) an expanded mixed-methods or quantitative study, (b) an examination of administrators' and other support services' influence on faculty development to improve course attrition rates at the community college level, (c) an examination of student-to-student interactivity in online mathematics and its effect on course attrition rates at the community college level, (d) an in-depth case study of a single community college, or a comparison of two competing community colleges' online mathematics departments that utilize the TPACK framework for professional development and/or assessment practices, and (e) an exploration of the Adult Learning Theory integrated with the TPACK framework."

4. Recent TPACK Presentations

Kulkarni, A. M., Gowrisankar, P., Madhavi, K., & Joseph, J. P. (2018, December). Learning and reflection of technology based collaborative MOOC design and its evaluation, validation and results. In V. Kumar, S. Murthy, Kinshuk, & S. Iyer (Eds.), *2018 IEEE Ninth International Conference on Technology for Education* (pp. 85–88). http://doi.ieeecomputersociety.org/10.1109/T4E.2018.00024

Abstract: "Information and Communication Technology (ICT) making a radical change in teaching learning practices. Content knowledge assimilation using technological pedagogical knowledge (TPK) is proven effective for learner centric approach. The rise of massive open online courses (MOOCs) made possible diverse learners to upgrade their knowledge and skills hence became a solution for facilitating access to quality education. This paper presents Learning and Reflection of Technology based Collaborative designed MOOC, the work is a essence of faculty development program on "Mentoring Educators in Educational Technology" course offered by IIT Bombay (IITB). Work done is a collaborative efforts of team assigned by IITB course team, participant's i.e. peer reviewers are also assigned by IITB course team for MOOC course designed by us. The MOOC designed team received guidelines from IITB course team, discussion forum, peers, social media group of peers and office hours conducted by IITB course team. The design team encouraged exploration of Technological pedagogical and Content Knowledge (TPACK) model to design learner centric MOOC. The team used the internet, social media to create connected learning experience and reflected throughout the process of development and conduction of MOOC. Validation of the results, reflection and analysis in this paper zeniths because the MOOC course creators and reviewers have completed Foundation Program in ICT for Education and Pedagogy for Online and Blended Teaching-Learning Process FDP with a score of 80% and above conducted by IIT Bombay."

Paneru, D. R., & Zounek, J. (2018, December). Information communication technology in teaching English as foreign language: An analysis of teaching methods in class from the perspective of journals. In R. Svaricek (Ed.), *ICET 2017: Re-thinking Teacher Professional Education: Using Research Findings for Better Learning Yearbook of Teacher Education* (pp. 194–210).

5. TPACK Newsletter Suggested Citation

Our thanks to Lisa Winebrenner, who wrote to suggest that *we* suggest a citation format for you 'academic types' who might want to cite something that appears in this humble virtual publication. Our reading of the most recent (6th edition) of the *Publication Manual of the American Psychological Association* suggests that the citation should look like this:

Harris, J., & Wildman, A. (Eds.). (2019, February 28). TPACK newsletter issue #39: February 2019 [Electronic mailing list message]. Retrieved from http://bit.ly/TPACKNewslettersArchive

6. Learning and Doing More with TPACK

Interested in learning more about TPACK or getting more involved in the TPACK community? Here are a few ideas:

- Visit the TPACK wiki at: http://tpack.org/
- Join the TPACK SIG at: http://site.aace.org/sigs/tpack-sig/

- Read past issues of the newsletter at: http://bit.ly/TPACKNewslettersArchive
- Subscribe to the tpack.research, tpack.teaching, tpack.grants and/or tpack.future discussion lists at: http://site.aace.org/sigs/tpack-sig/
- Access the TPACK Learning Activity Types taxonomies at: http://activitytypes.wm.edu/
- Access three tested TPACK assessment instruments at: http://activitytypes.wm.edu/Assessments
- Access and/or adapt TPACK online short courses at: http://activitytypes.wm.edu/shortcourse/

Please feel free to forward this newsletter to anyone who might be interested in its contents. Even better, have them subscribe to the TPACK newsletter by sending a blank email to sympa@lists.wm.edu, with the following text in the subject line: subscribe tpack.news FirstName LastName (of course, substituting their own first and last names for 'FirstName' and 'LastName' — unless their name happens to be FirstName LastName, in which case they can just leave it as is).

If you have a news item that you would like to contribute to the newsletter, send it along to: tpack.newsletter.editors@wm.edu.

Standard End-Matter

If you have questions, suggestions, or comments about the newsletter, please send those to tpack.newsletter.editors@wm.edu. If you are subscribed to the tpack.news email list, and — even after reviewing this impressive publication — you prefer not to continue to receive the fruits of our labors, please send a blank email message to sympa@lists.wm.edu, with the following text in the subject line: unsubscribe tpack.news

- Judi & Amelia

…for the SITE TPACK SIG leadership:
Teresa Foulger,   Co-Chair, Arizona State University
Yi Jin,   Co-Chair, Sonoma State University
Mamta Shah,   Plantation Chair, Drexel University
Josh Rosenberg,   Camping Chair, University of Memphis
Petra Fisser,   Red-Blue Chair, SLO Expertise Center, National Curriculum Development
Candace Figg,   Rocking Chair, Brock University
Mark Hofer,   Sedan Chair, William & Mary School of Education
Judi Harris,   Wing Chair, William & Mary School of Education
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