TPACK Newsletter, Issue #28: May 2016

Welcome to the twenty-eighth 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 Knowledge

"To know that we know what we know, and to know that we do not know what we do not know, that is true knowledge."
- Nicolaus Copernicus

In This Issue

1. TPACK Newsletter Update

The TPACK Newsletter has been published via the tpack.news email list since January 2009. It has 1177 subscribers currently. Subscription numbers have held steady (+ or – 1% to 3%) since October 2011.

2. Recent TPACK Publications

Below are recent TPACK publications that we know about: 35 articles, 14 chapters, 1 book, and 2 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: tpacknews.editors@wm.edu.

Articles

Akyüz, D. (2016). TPACK analysis of preservice teachers under different instruction methods and class levels. *Turkish Journal of Computer and Mathematics Education, 7*(1), 89-111. doi:10.16949/turcomat.75768

Abstract: "The importance of the use of technology in mathematics education has been demonstrated by many studies. Effective use of technology has been found to support the conceptual understanding of students. However, it is also found that, having only technological knowledge is not sufficient for using technology effectively in teaching mathematics; technological knowledge must be supported by pedagogical and content knowledge as well. It is stated that a teacher who effectively integrates these three types of knowledge has technological pedagogical content knowledge (TPACK). In order for teachers to acquire this knowledge, it is important for them to take courses that support TPACK during their pre-service training. However, the type of instruction that they receive during such a course may have an impact on whether they actually acquire TPACK or not. In this study, we investigate a total of 80 pre-service teachers who took a class called "Exploring Geometry with Dynamic Geometry Applications" with different types of instruction over the course of 5 semesters. The participants involved a mixed group of junior, senior, and graduate students which allowed us to analyze the effect of class level and the type of instruction in the student's ability to acquire TPACK. To analyze the students' TPACK level, we performed document analysis using the theoretical framework developed by Bowers and Stephens after reinterpreting it based on the literature and the data collected during this study. It was found that the majority of the graduate students achieved Technological Content Knowledge (TCK). Additionally, it was observed that the type of instruction as well as students' class level is important in developing TPACK. The obtained results allow us to make conclusions about how the contents and the instruction method of a course should be designed such that it better promotes TPACK achievement."

Ansyari, M. F. (2015). Designing and evaluating a professional development programme for basic technology integration in English as a foreign language (EFL) classrooms. *Australasian Journal of Educational Technology, 31*(6), 699-712. doi: 10.14742/ajet.1675

Abstract: "This study aims to develop and evaluate a professional development programme for technology integration in an Indonesian university's English language teaching setting. The study explored the characteristics of this programme to English lecturers' technological pedagogical content knowledge (TPCK) development. This design-based research employed interviews, a data logbook, TPACK (Total PACKage) surveys, teacher attitudes toward computer (TAC) surveys, and a technology integration assessment rubric. Results show that participants had positive experiences with the professional development programme. TPCK was also enhanced after the professional development activities based on self-reported TPACK survey. Overall, evidence from all data sources shows that the professional development arrangement for technology integration improves the English lecturers' TPCK. Crucial aspects of a

professional development programme should include the TPACK framework as a knowledge base, the design approach, active engagement, authentic learning experiences in a collaborative environment, curriculum coherency, an intensive programme schedule, guidance, support, and feedback."

Aquino, A. B. (2015). Self-efficacy on technological, pedagogical and content knowledge (TPACK) of biological science pre-service teachers. *Asian Pacific Journal of Multidisciplinary Research, 3*(4.3), 150-157. Retrieved from https://doaj.org/article/b8019779fd70454fa65a74bf559576b5

Abstract: "The teachers are the focal figure in education and play vital roles in learning. These roles have served as key point in designing the curriculum and preparing pre-service teachers. Turning students into competent teachers is an interplay of varied factors, one of which is technology. This impact necessitates the utilization of technology in teaching, described as technological pedagogical content knowledge (TPACK). The study aimed to investigate TPACK self-efficacies of pre - service biological science teachers who were enrolled in two academic years at the College of Teacher Education in a state university in the Philippines. It also examined whether the responses of the two groups of respondents on TPACK self – efficacy differ and whether these self-efficacies relate to sex, electronic gadget owned and access to internet. It used the descriptive survey method of research employing a questionnaire on TPACK to collect data. The study found out that there is more female than male. Majority have electronic gadgets but have limited access to internet. Findings showed that respondents have good TPACK self – efficacy. The findings showed that the responses of the two groups of participants on TPACK self – efficacies are statistically different . Further, their self – efficacies is very slightly affected by their sex, electronic gadgets owned and access to internet. The study recommends reviewing and improving instructional practices and curriculum of the college to enhance TPACK of respondents."

Banas, J. R., & York, C. S. (2014). Authentic learning exercises as a means to influence preservice teachers' technology integration self-efficacy and intentions to integrate technology. *Australasian Journal of Educational Technology, 30*(6), 728-746. doi:10.14742/ajet.362

Abstract: "This study explored the impact of authentic learning exercises, as an instructional strategy, on preservice teachers' technology integration self-efficacy and intentions to integrate technology. Also explored was the predictive relationship between change in preservice teachers' technology integration self-efficacy and change in intentions to integrate technology. Participants included 104 preservice teachers enrolled into a professional preparation methods course. Technology integration self-efficacy was measured as perceived technological knowledge (TK), pedagogical knowledge (PK), technological pedagogical knowledge (TPK), pedagogical content knowledge (PCK), and technological pedagogical content knowledge (TPACK). A paired samples t-test revealed a significant increase in self-efficacy for all TPACK constructs, as well as intentions to integrate technology. The effect was greatest for PCK. Also, multiple regression analysis revealed change in technology integration self-efficacy as a model,

predicted change in intentions to integrate. Particularly change in perceived technology knowledge, predicted change in intentions. Implications for professional preparation programs are shared."

Baran, E., & Uygum, E. (2016). Putting technological, pedagogical, and content knowledge (TPACK) in action: An integrated TPACK-design-based learning (DBL) approach. *Australasian Journal of Educational Technology, 32*(2), 47-63. doi:10.14742/ajet.2551

Abstract: "Design-based learning (DBL) has been considered a useful approach in teacher education because of its emphasis on the investigation of technology integration problems in design processes. Despite recent interest in understanding how technological, pedagogical, and content knowledge (TPACK) translates to action, limited research exists on how TPACK is developed within DBL contexts and what principles of DBL can be applied to TPACK development. To address these critical gaps in the literature, an approach was developed that outlined eight DBL principles that foster understanding of TPACK-in-action in teacher education contexts. Next, a graduate course was designed to determine how course activities facilitated understanding of TPACK-in-action and to what extent students enacted TPACK-DBL principles. Following a case study methodology, data were collected from 10 graduate students through reflection reports, design guides, and researcher observation notes. The analysis of qualitative and descriptive data revealed that as a result of TPACK-DBL activities, students developed a four-dimensional understanding of TPACK-in-action: theory-practice connection, readiness for practice, technological proficiency, and sustainable learning of TPACK. The results offer recommendations to teacher educators for developing understanding of TPACK-in-action through DBL activities."

Belo, N., McKenney, S., Voogt, J., & Bradley, B. (2016). Teacher knowledge for using technology to foster early literacy: A literature review. *Computers in Human Behavior, 60*, 372-383. doi:10.1016/j.chb.2016.02.053

Abstract: "A literature review was conducted to describe the knowledge and skills teachers need for using technology to foster early literacy development in kindergarten classrooms. The study was guided by three research questions, concerning 1) effects of specific technologies, 2) effective design characteristics and 3) effective use of such applications. The sample consisted of 46 articles that reported on the affordances of technology in relation to kindergartners' early literacy development. The review included studies on electronic books, computer-based training programs, technology-rich literacy curricula, assistive technology, and other educational media and sources for technology-rich literacy education. The following software applications were found effective in fostering kindergartners' early literacy development: Electronic storybooks, computer-based phonics and vocabulary training programs, software applications that enable children to 'read and write', software applications that are designed for tutorial activities, and educational television programs with a narrative format. Few of the studies reviewed provided specific information about effective design characteristics of such applications or concrete guidelines for using technology in developmentally appropriate fashion in kindergarten. Theoretical and practical implications are discussed."

Bilici, S. C., Guzey, S. S., & Yamak, H. (2016). Assessing pre-service science teachers' technological pedagogical content knowledge (TPACK) through observations and lesson plans. *Research in Science & Technological Education, 34*(2), 237-251. doi:10.1080/02635143.2016.1144050

Abstract:
"Background: Technological pedagogical content knowledge (TPACK) is critical for effective teaching with technology. However, generally science teacher education programs do not help pre-service teachers develop TPACK.

Purpose: The purpose of this study was to assess pre-service science teachers' TPACK over a semester-long Science Methods.

Sample: Twenty-seven pre-service science teachers took the course toward the end of their four-year teacher education program.

Design and method: The study employed the case study methodology. Lesson plans and microteaching observations were used as data collection tools. Technological Pedagogical Content Knowledge-based lesson plan assessment instrument (TPACK-LpAI) and Technological Pedagogical Content Knowledge Observation Protocol (TPACK-OP) were used to analyze data obtained from observations and lesson plans.

Results: The results showed that the TPACK-focused Science Methods course had an impact on pre-service teachers' TPACK to varying degrees. Most importantly, the course helped teachers gain knowledge of effective usage of educational technology tools.

Conclusion: Teacher education programs should provide opportunities to pre-service teachers to develop their TPACK so that they can effectively integrate technology into their teaching."

Blackwell, C. K., Lauricella, A. R., & Wartella, E. (2016). The influence of TPACK contextual factors on early childhood educators' tablet computer use. *Computers & Education, 98*, 57-69. doi: 10.1016/j.compedu.2016.02.010

Abstract: "Tablet computers are increasingly becoming commonplace in classrooms around the world. More than half of early childhood educators in the U.S. now have access to tablets, making it imperative to understand how they are using the device and what influences such use. The current study draws on survey data from 411 preschool educators serving 3- to 5-year-olds in school-based, center-based, and Head Start preschool programs to investigate how TPACK contextual factors (e.g., student background, teacher attitudes, and school support) influence teachers' traditional and student-centered tablet computer practices. Results suggest that teacher-level factors—especially positive attitudes toward technology—are most influential. Overall, this study emphasizes the need for preschool teachers and teacher educators to understand and address the critical contextual factors of tablet computer use in

preschool education. Implications for education policy include expanding traditional funding models beyond technology access to provide on-going educator support, and developing new initiatives that encourage novel professional development models based on the same learned-centered practices that teachers are encouraged to use themselves."

Boschman, F., McKenney, S., Pieters, J., & Voogt, J. (2016). Exploring the role of content knowledge in teacher design conversations. *Journal of Computer Assisted Learning, 32*(2), 157-169. doi: 10.1111/jcal.12124

Abstract: "This study investigated the role of content knowledge in conversations of kindergarten teachers during collaborative curriculum design of learning material for technology-enhanced learning. Two teams of teachers received support from an early literacy expert during these design activities. Resulting conversations were analyzed on technological pedagogical content knowledge, explicated reasoning, and the contributions of expert support. This study found that in explicating content knowledge and pedagogical content knowledge, teachers set goals and deliberated on strategies and activities that would be most appropriate for their students. Technological content knowledge and technological pedagogical content knowledge were explicated most during deliberations on practical concerns; these mainly revolved around optimizing the affordances of technology. This study contributes to understanding and supporting the pedagogical design capacity of teachers."

Bouck, E. C. (2016). A national snapshot of assistive technology for students with disabilities. *Journal of Special Education Technology, 31*(1), 4-13. doi: 10.1177/0162643416633330

Abstract: "Assistive technology (AT)—included in the Individuals with Disabilities Education Act since 1990—supports students with disabilities. Yet, research repeatedly suggests an underutilization of AT. This study represents a secondary analysis of the National Longitudinal Transition Study-2 focused on understanding issues of AT for secondary (i.e., high school) students with disabilities. The study presents the self-reported and educator-reported rates of AT receipt by secondary students with disabilities, both aggregated and disaggregated by disability group. The results suggest low rates of self-reported and educator-reported AT access and/or use for secondary students with disabilities but higher rates of AT for secondary students with more low-incidence disabilities than students with more high-incidence disabilities."

Courduff, J., Szapkiw, A., & Wendt, J. L. (2016). Grounded in what works: Exemplary practice in special education teachers' technology integration. *Journal of Special Education Technology, 31*(1), 26-38. doi:10.1177/0162643416633333

Abstract: "The purpose of this systematic grounded theory study was to extend the theoretical foundations of the technology acceptance model (TAM) and the technological pedagogical content knowledge (TPACK) model to generate a theoretical model explaining the process leading to exemplary integration of technology into special education instructional practice. Data were -collected through demographic surveys, interviews, and observations of a

purposeful selection of participants. Participants were selected based on exemplary practice criteria determined by an expert focus group. Data were analyzed using open coding, axial coding, and selective coding to gain a categorical understanding of the pedagogy used by special education teachers in successfully integrating technology into teaching and learning. Final analysis revealed a cycle of four components leading to teachers' initial and ongoing technology adoption into classroom activities: (a) opportunities, (b) dispositions, (c) pedagogical beliefs, and (d) small steps. Skill and knowledge levels were salient themes in the process of technology integration. However, underlying these themes were key beliefs and dispositions that proved foundational in leading to exploration and exemplary integration of technology. While obstacles existed, they were ultimately overcome or overlooked due to these key beliefs and dispositions. Implications provide insight into how educators and researchers can improve preservice coursework and professional development for technology integration within special education instruction."

Ersanli, C. Y. (2016). Improving technological pedagogical content knowledge (TPACK) of pre-service English language teachers. *International Education Studies, 9*(5), 18-27. doi:10.5539/ies.v9n5p18

Abstract: "Developing as teachers and optimizing learning experiences for future students is the ultimate goal in technology use in teacher education programs. This study aims to explore the effectiveness of a five-week workshop and training sessions on Technological Pedagogical Content Knowledge (TPACK) of pre-service English language teachers. The participants are 59 pre-service English language teachers enrolled in an ELT Methodology Course at a state university. The data is gathered through the TPACK Scale developed by Solak and Çakır (2014) and journal entries of pre-service English language teachers before and after the procedure. The results indicate a statistically significant improvement in TPACK scores of both male and female pre-service English language teachers. The journal entries clearly indicate an increase in several possible applications or websites that can be used in the classroom with more effective and to the point objectives. The pre-service English language teachers have also displayed better performance in manufacturing and tailoring language learning/teaching materials with specific goals."

Gao, P., Tan, S. C., Wang, L., Wong, A. F. L., & Choy, D. (2011). Self-reflection and preservice teachers' technological pedagogical content knowledge: Promoting earlier adoption of student-centered pedagogies. *Australasian Journal of Educational Technology, 27*(6), 997-1013. doi:10.14742/ajet.925

Abstract: "The purpose of this paper is to present the qualitative findings relating to fourteen preservice teachers' development and translation of their technological pedagogical knowledge (TPK) into their classroom practices throughout the first year of their teacher preparation program. It was found that all fourteen participants demonstrated a gain in both technological and pedagogical knowledge, and registered positive changes both in their pedagogical beliefs and their beliefs in using information and communication technology (ICT) to engage their students in active meaning making after an ICT course and an intervention workshop on

reflection. There was, however, great variation in the ways that they used ICT in their first field placements: from using ICT as a presentation tool to complement or support their teaching, to engaging their students in using ICT as a cognitive tool to extend their students' learning and knowledge construction. This variation was largely related to whether the participants could synergise their constructivist-oriented beliefs, technological knowledge and pedagogical knowledge. It seems that only the preservice teachers who demonstrated student-centric pedagogies and reflected on student learning showed more advanced development of TPK. Recommendations for engaging preservice teachers in reflection with a focus on student learning are discussed."

Holland, D. D., & Piper, R. T. (2016). Testing a technology integration education model for millennial preservice teachers: Exploring the moderating relationships of goals, feedback, task value, and self-regulation among motivation and technological, pedagogical and content knowledge competencies. *Journal of Educational Computing Research, 54*(2), 196-224. doi: 10.1177/0735633115615129

Abstract: "The technology integration education model is a 12 construct model that includes 8 primary constructs and 4 moderator constructs. By testing the relationships among two primary constructs (motivation and technological, pedagogical, and content knowledge competencies) and four moderator constructs (goals, feedback, task value, and self-regulation), this study advances technological, pedagogical, and content knowledge research. This study investigated three research questions and found that goals, feedback, task value, and self-regulation moderated the predictive form relationships among intrinsic motivation and technological knowledge, pedagogical knowledge, and content knowledge. However, only goals moderated the explanation form relationship between intrinsic motivation and technological knowledge. This study provided data-driven insights for educators of preservice teachers as they continue to become evidence-based managers and data-driven decision makers. Educators may be misallocating resources if they only focus on self-determination motivation theory and applications and never consider whether goals, feedback, task value, and self-regulation interact with motivation. The researchers created a new instrument consisting of a 16-item measure of the goals construct and a 6-item measure of the feedback construct. For this exploratory study, the sample consisted of 90 elementary education majors and 51 secondary education majors."

Hsu, L. (2016). Are you ready to use technology in EFL teaching? Examining psychometric properties of EFL teachers' technological pedagogical content knowledge (TPACK) scale. *International Research in Education, 4*(1), 97-110. doi:10.5296/ire.v4i1.8740

Abstract: "It has been confirmed that technology can be beneficial for students' academic performance, including in the field of computer-assisted language learning (CALL). The successful administration of CALL depends greatly on the teachers' knowledge about technology, pedagogy and content. The aim of this study is to explore the psychometric property of measure of EFL teachers' technological, Pedagogical and content knowledge (TPACK). One hundred and fifty-eight EFL teachers were invited to join this study through

stratified randomization sampling technique. The research instrument was the TPACK-EFL and the exploratory factor analysis (EFA) with extraction method of Maximum Likelihood and the rotation method of Promax with Kaiser Normalization, was performed to extracted factors with factor loading above .50. Seven constructs (Technological Knowledge, Pedagogical Knowledge, Content Knowledge, Technological Pedagogical Knowledge, Technological Content Knowledge, Pedagogical Content Knowledge and Technological Pedagogical Content Knowledge) were retrieved. Afterwards, the Confirmatory Factor Analysis (CFA) was undertaken to examine the convergent and discriminant validity of selected factors. Convergent validity was checked with Composite Reliability (CR), Average Variance Extracted (AVE), Maximum Shared Variance (MSV), and Average Shared Variance (ASV). Suggested value for CR and AVE was .6 and .5 respectively while MSV as well as ASV should be lower than AVE. Results showed that constructs of this study all met the requirement which indicated that the items had convergent validity. In terms of discriminant validity, square root of AVE was greater than inter-construct correlations which asserted the discriminant validity of this instrument. Subsequently, alternate model analysis was conducted to yield the model which fitted the best as indicated by the model fit indices and research context."

Inayati, N. (2015). English language teachers' use of social media technology in Indonesian higher education context. *Asian EFL Journal Research Articles, 17*(4), 6-36. Retrieved from https://www.researchgate.net/profile/Nina_Inayati/publication/290654217_English_language_teachers'_use_of_social_media_technology_in_Indonesian_higher_education_context/links/56f0dde808aeedbe3ce44456.pdf

Abstract: "Social media technology (SMT) has exerted a great influence on many aspects of life, including English education. The literature has shown various types of SMT employed in a range of English Language Teaching (ELT) contexts. This study explores the emerging trend of SMT use in ELT in Indonesian higher education contexts. This survey study observes the ELT faculty members of a language centre in a prominent private university in Indonesia. The findings showed that Facebook and YouTube were the most frequently used types of SMTs by the language centre faculty members. In addition, analysis showed that, although most the faculty members were aware of the benefits of SMTs in teaching and used a range of SMTs for various personal and professional purposes, they were reluctant to use it in the classroom. This phenomenon was explained using the framework of Planned Behaviour theory. The analysis using SPSS 20 revealed that the behavioural control of using SMTs was limited due to insufficient institutional infrastructure and support. This small scale study offers some insights into the faculty members' perceptions of SMT use in ELT in the Indonesian context, which could, to some extent, be generalized to other similar developing countries."

Jang, S.-J., & Chang, Y. (2016). Exploring the technical pedagogical and content knowledge (TPACK) of Taiwanese university physics instructors. *Australasian Journal of Educational Technology, 32*(1), 107-122. doi:10.14742/ajet.2289

Abstract: “University science teachers’ technological pedagogical and content knowledge (TPACK) is crucial for effective teaching. Although there has been a plethora of studies investigating pre-service and in-service teachers’ TPACK, few studies have examined university instructors’ TPACK and university students’ perceptions of instructors’ TPACK. The main purpose of this study was to examine the TPACK questionnaire differences between university students’ perceptions and instructors’ self-perceptions, and assess differences in university physics instructors’ TPACK according to gender, academic degrees and teaching experience in Taiwan. This study adopted and revised an instrument for measuring university students’ perceptions of science instructors’ TPACK. The sample was randomly selected from the physics instructors of universities in the northern, central, and southern regions of Taiwan. Exploratory factor analysis was conducted to examine the dimensions of the instrument. The results revealed that the TPACK questionnaire of university physics instructors’ views were different from the university students’ perceptions. University physics instructors’ results indicated statistical significance in overall TPACK according to teaching experience. The research implications of this study are provided along with suggestions.”

Janssen, N., & Lazonder, A. W. (2016). Supporting pre-service teachers in designing technology-infused lesson plans. *Journal of Computer Assisted Learning*. Advance online publication. doi: 10.1111/jcal.12146.

Abstract: “The present study compared the effectiveness of two types of just-in-time support for lesson planning. Both types contained the same technological information but differed regarding pedagogical and content information. The first type presented this information separately (i.e., separate support); the second type presented this information in an integrated way (i.e., integrated support). In an experimental design pre-service biology teachers received either the integrated support (n = 26) or separate support (n = 27). They were instructed to create a technology-infused lesson plan and justify their design decisions. Results showed that pre-service teachers who used the integrated support had more integrated pedagogical and content-related justifications and higher quality lesson plans than the group who received separate support. Both groups had few technology-related justifications, and technology integration was of low quality. These findings confirm the alleged superiority of integrated support over separate support, and suggest that additional guidance is needed for pre-service teachers to fully integrate technological, pedagogical and content information during lesson planning.”

Kihoza, P., Zlotnikova, I., Bada, J., & Kalegele, K. (2016). Classroom ICT integration in Tanzania: Opportunities and challenges from the perspectives of TPACK and SAMR models. *International Journal of Education and Development using Information and Communication Technology, 12*(1), 107-128. Retrieved from http://ijedict.dec.uwi.edu/viewarticle.php?id=2035

Abstract: “With the education systems demand of contemporary technologies, teacher trainees should be imparted with competencies and skills to integrate information and communication technology (ICT) into their future teaching and learning practices. This study assessed classroom

ICTs integration opportunities and the challenges in relation to Technological Pedagogical and Content Knowledge (TPACK) and SAMR (Substitute, Augmentation, Modification, and Redefinition) models. The case study involved tutors and teacher trainees (N=206) from teacher training colleges. Results indicated that, majority of respondents have low pedagogical ICT competencies. However, tutors exhibited good knowledge level in all TPACK and SAMR constructs that we assessed, teacher trainees' revealed poor skills and inefficient support on the use of basic ICTs (hardware, software, and associated peripherals). The impacts of TPACK and SAMR models characteristics related to the technology use planning and redesign of learning tasks was evident. Most of the challenges identified were associated to the lack of infrastructures, readiness to change and lack of competencies on pedagogical ICTs applications. Among others, we recommend the government to work on a harmonized ICT in education integration framework; that consider the existing opportunities and challenges facing Tanzania teacher training systems. Further work should focus on carrying out an experimental research design to unlock the existing ICT use realities."

Koehler, M. J., Mishra, P., & Cain, W. (2013). What is technological pedagogical content knowledge (TPACK)? *Journal of Education, 193*(3), 29-37. Retrieved from http://revistas.unc.edu.ar/index.php/vesc/article/view/11552/11983

Editors' note: This article is a translation into Spanish of the 2013 article cited above.

Abstract: "This paper describes a teacher knowledge framework for technology integration called technological pedagogical content knowledge (originally TPCK, now known as TPACK, or technology, pedagogy, and content knowledge). This framework builds on Lee Shulman's (1986, 1987) construct of pedagogical content knowledge (PCK) to include technology knowledge. The development of TPACK by teachers is critical to effective teaching with technology. The paper begins with a brief introduction to the complex structur[al] nature of teaching. The nature of technologies (both analog and digital) is considered, as well as how the inclusion of technology in pedagogy further complicates teaching. The TPACK framework for teacher knowledge is described in detail as a complex interaction among three bodies of knowledge: content, pedagogy, and technology. The interaction of these bodies of knowledge, both theoretically and in practice, produces the types of flexible knowledge needed to successfully integrate technology use into teaching."

Kontkanen, S., Dillon, P., Valtonen, T., Eronen, L., Koskela, H., & Väisänen, P. (2016). Students' experiences of learning with iPads in upper secondary school – A base for proto-TPACK. *Education and Information Technologies.* Advance online publication. doi:10.1007/s10639-016-9496-7

Abstract: "This research focuses on Finnish students' (*n* = 84) experiences of using personal iPads in their studies through 3 years of upper secondary schooling. It is based on results from one of the first schools in Finland where all the new students were provided with iPads at the start of their studies. Data consists of: (i) 127 short stories written by students about how they would advise a new teacher and a new student to use iPads in teaching and learning, and (ii)

four group discussions on the same topics. Qualitative thematic analysis of the data was guided by the TPACK framework. Results suggest that: (i) teachers' pedagogical approaches changed little in response to the new devices and remained largely teacher-centred, and (ii) students do not have the confidence to radically change learning styles to take advantage of the affordances of the devices. The value that iPads add to teaching and learning is difficult to quantify because of the complex and often conflicting factors involved. Overall, the findings imply that teachers' TPACK is generally resistant to change and students' proto-TPACK is insufficiently developed to initiate change. An approach that systematically develops both students' *and* teachers' TPACK is advocated."

Köse, N. K. (2016). Technological pedagogical content knowledge of English language instructors. *Journal of Educational and Instructional Studies in the World, 6*(2), 12-19. Retrieved from http://www.wjeis.org/FileUpload/ds217232/File/02.naran_kayacan_kose.pdf

Abstract: "The aim of the study is to investigate the perceptions of English language instructors' Technological Pedagogical Content Knowledge (TPACK) within the context of teaching EFL. The participants of the study consist of 127 language instructors teaching English at different levels at different state universities in Turkey. Data were collected by means of TPACK-EFL Survey (Baser, Kopcha & Ozden, 2015) with some demographic questions and other questions included by the researcher to gather in-depth information about technology use in teaching. According to the results of the study, English language instructors feel themselves the most competent in their subject matter, English language. However, do not think that they were highly competent in integrating technology into their content teaching with sound pedagogy."

Lai, T.-L., & Lin, H.-F. (2015). Exploring mathematics teachers' perception of technological pedagogical content knowledge. *Journal of Educational Media & Library Sciences, 52*(1), 59-82. doi:10.6120/JoEMLS.2015.521/0642.RS.CE

Abstract: "The purpose of the study is to develop an instrument for junior high school mathematics teachers to evaluate their technological pedagogical content knowledge. The survey tool is based on Koehler and Mishra's TPACK framework and strengthened mathematics content knowledge and pedagogical content knowledge in the framework. 526 junior high school mathematics teachers in Taiwan were recruited to validate the survey. Confirmatory factor analysis was applied to examine the validity. The results showed that survey tool reached good validly and reliability. We also explored gender, age, and seniority and other demographic factors to reflect current junior high school mathematics teachers' TPACK in Taiwan."

Laster, B., Tysseling, L., Stinnett, M., Wilson, J., Cherner, T., Curwen, M.,…Huggins, S. (2016). Effective use of tablets (iPads) for multimodal literacy learning: What we learn from reading clinics/literacy labs. *The App Teacher Journal, 1*(1). Retrieved from http://appedreview.com/blog/effective-use-tablets-ipads-multimodal-literacy-learning-learn-reading-clinicsliteracy-labs/

Abstract: “In this study, teachers used tablets (iPads) for literacy instruction. The survey data were collected at five university-based reading clinics that were geographically dispersed. Results showed the gains made by teachers in using apps for a range of literacy instructional purposes, including advancing clients’ comprehension and writing. In self-reports at the end of the semester, teachers gave voice to their increased confidence and diminished concerns—as compared to what they expressed at the beginning of the semester. Observations of the teachers confirmed their increased knowledge and skill in using tablet technology in a range of ways to support the literacy development of K-12 learners. Post-test responses were significantly more positive than pre-test responses.”

Maor, D. (2016). Using TPACK to develop digital pedagogues: A higher education experience. *Journal of Computers in Education*. Advance online publication. doi:10.1007/s40692-016-0055-4

Abstract: “This paper explores the use of the TPACK model in two higher education e-learning courses in Australia that enhanced students’ ability to use technology in their learning and later in their professions. The courses focused on teaching students becoming *digital pedagogues* who could integrate technology and pedagogy and be more interactive teachers using the latest technologies. The aims of the two courses were to encourage students to become reflective learners and to create knowledge collaboratively. Newer technological tools, such as iPads, ePortfolios, and eBooks, were used to create *digital pedagogies* to enhance the students’ learning experience and obtain students’ reflections on the course. To maximize students’ learning, TPACK was used in the design of the course, the learning activities and the assessment. It was also used as a framework to analyze the data. Results from the survey data found that students increased their confidence and their understanding of the use of the different domains of TPACK. The study also found that the majority of students became digital pedagogues and took the opportunity to implement the TPACK model in their classrooms. It contributes to understanding the value of the overlapping area of TPACK and the conceptual space necessary to implement digital pedagogies.”

Messina, L., & Tabone, S. (2011). Integrating technology into instructional practices: A training research-intervention with in-service teachers. *REM-Research on Education and Media, 3*(1), 142-163. Retrieved from https://www.researchgate.net/publication/255886528_L_Messina_S_Tabone_2011_Integrating_technology_into_instructional_practices_A_training_research-intervention_with_in-service_teachers_REM-Research_on_Education_and_Media_31_142-_163_ISSN_2037-0849

Abstract: “This article concerns a training intervention, based on the Technological, Pedagogical And Content Knowledge-TPACK framework developed by Koehler & Mishra (2005; Mishra & Koehler, 2006), and involving 110 lower secondary school teachers in the Italian Region of Veneto participating in the Cl@sses 2.0 Action. After a short introduction of Cl@sses 2.0 Action and TPACK framework, the article presents some results obtained through a questionnaire submitted to teachers, aimed at surveying their knowledge with respect to the areas of the

TPACK framework. Finally, suggestions to guide teachers in implementing TPACK and developing flexible knowledge to integrate technologies into instructional practices are concisely presented."

Mouasher, A., & Lodge, J. M. (2016). The search for pedagogical dynamism: Design patterns and the unselfconscious process. *Educational Technology & Society, 19*(2), 274-285. Retrieved from http://www.ifets.info/journals/19_2/20.pdf

Abstract: "An apparent paradigm shift has created increased impetus to offer higher education across multiple delivery platforms. Utilising technology can support design and delivery for enhanced learning, albeit with additional pressures on academic workloads, affecting the ability to deliver quality formal education that meets the needs of individuals and society. The issue is exacerbated when technology, not pedagogy, drives decision-making, and further intensified by the formalisation of education. Using Mishra and Koehler's TPACK framework, we argue that pedagogical dynamism is both necessary to maintain equilibrium of content-knowledge-pedagogy and a natural outcome. Further we suggest it is possible using Alexandrian design patterns and a return to the "unselfconscious process." We critique existing design pattern work in education, and contribute a metatheoretical exploration of alexander's principles and patterns to designing good-fitting forms impacting education. A scenario of designing for "online," "on-campus" and "multi-mode" delivery of education is woven throughout to highlight implications for teaching practice."

Muhamad, N. A. B. (2014). Investigating the roles of motivation and technological pedagogical content knowledge (TPACK) in computer-mediated communication (CMC) speaking skills instruction. *International Journal of Applied Linguistics and English Literature, 3*(2), 112-130. Retrieved from https://doaj.org/article/e12b028395d64bb492574d0746d4d795

Abstract: "The computer-mediated approach is deemed as an effective way to assist in improving the communicative skills among ESL learners. This study presents a mixed-methods research. It aims to identify the level of motivation of the CMC users in learning English speaking skills, and how they relate to speaking achievements. This research investigates how the content knowledge (CK), pedagogical knowledge (PK) and the technological knowledge (TK) of the facilitators influence the motivation of the learners. Data is analysed comparing the pre-post tests. Inferential Statistics method which uses the correlation analysis is carried out to see the relationship between the factors and the level of the speaking competency. Moreover, the data is triangulated with the inclusion of audio- taped interview data. 154 students and 4 language facilitators were randomly selected from one of the institutes of higher education in Malaysia. The findings indicate that the learners' speaking competency levels show significant improvement compared to the early stage of the research. However, there is no significant difference between the results of pre-post tests in terms of the motivation level and results also did not show significant relationship between motivation and the improvement of the speaking competency level. This shows that motivation level was not the leading factor that influenced improvement in the proficiency levels of the students. The interviews with the ESL learners showed that they had dissatisfactions regarding their online learning programme and they also

indicated that their facilitators lacked of Content, Pedagogical and Technological Knowledge (TCPK) in facilitating their online learning as these knowledge are important in the online learning environment. As the conclusion, ESL learners improved their speaking proficiency through CMC learning but there are other external factors beyond the scope of this research that need to be investigated further."

Muir, T., Callingham, R., & Beswick, K. (2016). Using the IWB in an early years mathematics classroom: An application of the TPACK framework. *Journal of Digital Learning in Teacher Education, 32*(2), 63-72. doi: 10.1080/21532974.2016.1138913

Abstract: "This article presents a case study of one particular lesson in which a teacher uses the features of an interactive whiteboard (IWB) to teach mental computation strategies to a Grade 1 class. The framework of Technological Pedagogical Content Knowledge (TPACK) is used to evaluate the teacher's use of the IWB to teach mathematical concepts to young children. The findings demonstrate that the TPACK framework can be useful in considering the mathematics knowledge required for teaching in the early years and helpful for describing teaching practices that incorporate technology. The study has implications for teachers and teacher educators who may use the framework to understand teaching approaches using technology with the aim of enhancing early years' classroom practice."

Önal, N. (2016). Development, validity and reliability of TPACK scale with pre-service mathematics teachers. *International Online Journal of Educational Sciences.* Advance online publication. doi: 10.15345/iojes.2016.02.009

Abstract: "The purpose of this study is to develop a TPACK (Technological Pedagogical Content Knowledge) scale based on the main components of TPACK framework. The validity and reliability studies of the scale were carried out with 316 Turkish pre-service mathematics teachers at seven different universities in Turkey. The Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) of the scale were carried out. The Cronbach's alpha reliability coefficient for the whole scale was found as .97. This scale consists of 59 items and nine factors. With the exploratory factor analysis nine constructs were found: technological knowledge (TK), content knowledge (CK), pedagogy knowledge (PK), pedagogical content knowledge (PCK), technological content knowledge (TCK), online technological pedagogical knowledge (TPK online), offline technological pedagogical knowledge (TPK offline), technological pedagogical content knowledge (TPCK) and contexts knowledge. According to the CFA results of scale, the ratio of the chi-square value (2866.53) to the degree of freedom (1616) was 1.77. In addition, the goodness-of-fit values for the model revealed by the CFA were SRMR=0.047 and RMSEA=0.050. The development of both reliable and valid scale related to the technological pedagogical content knowledge of pre-service mathematics teachers' would be promote further studies."

Polly, D. & Rock, T. (2016). Elementary education teacher candidates' integration of technology in the design of interdisciplinary units. *TechTrends.* Advance online publication. doi: 10.1007/s11528-016-0059-y

Abstract: “In this paper the authors evaluate 85 elementary education teacher candidates’ integration of technology into interdisciplinary units that the candidates wrote during the semester before their full-time student teaching internship. An inductive analysis of the units revealed that teachers used a wide variety of technologies with a large dependence on Internet-based technologies, interactive whiteboards, and iPad applications. Further analyses found that most of the technology uses were lower-level and focused on only basic skills. However, chi-squared tests for independence found statistically significant relationships between numerous factors and when technology was used in ways that addressed higher-order thinking skills. These factors included the structure of the lesson plans, the content of the interdisciplinary units, when the technology was integrated into the multi-lesson unit, and when the technology was integrated into specific phases of the lesson. Implications for teacher education programs and research that focuses on teacher candidates’ TPACK are provided.”

Roig-Vila, R., Mengual-Andres, S., & Quinto-Medrano, P. (2016). Primary teachers’ technological, pedagogical, content knowledge. *Comunicar, 45*(23), 151-159. doi:10.3916/C45-2015-16

Abstract: “The emergence of Information and Communication Technologies (ICTs) poses new educational challenges for teachers, to which it can respond from a consistent training model. This study has as its aim to analyze the technological, pedagogical and content knowledge needed for Primary Education teachers to integrate ICTs into teaching. A research work based on a quantitative non-experimental methodology which involved 224 Preschool and Primary Education teachers working in the province of Alicante (Spain) was performed with that aim. The important results showed that teachers are more knowledgeable in the pedagogical and content fields than in technology, which means that their level of technological knowledge does not suffice to integrate ICTs into their teaching tasks. Significant differences were additionally identified between gender and years of experience, together with the relationship between the fun use of technology and the knowledge of its essential aspects. Our findings confirm the need for a digital literacy campaign addressed to teachers, involving not only a technological type of training but also an overall pedagogical and content approach. This is in keeping with the TPACK model (Technological, Pedagogical and Content Knowledge), which appears as a reference framework to be taken into account when it comes to teachers’ professional development and its connection with the teaching-learning processes in the classroom wherever Information and Communication Technologies are present.”

Voogt, J., & McKenney, S. (2016). TPACK in teacher education: are we preparing teachers to use technology for early literacy? *Technology, Pedagogy, and Education*. Advance online publication. doi: 10.1080/1475939X.2016.1174730

Abstract: “This study examines if and how five teacher education institutes are helping students to develop the technological pedagogical content knowledge needed to effectively use technology for early literacy. Focus group discussions were held with teacher educators in which their responses to expert recommendations were probed. Findings indicate that, currently, very little attention is specifically given to the knowledge that teachers need to foster

early literacy through the use of technology. This is due to multiple factors, including the conviction that many new technologies (e.g. tablets) are not used much in schools. Additionally, teacher educators themselves struggle with effective use of technology in their own courses. And although technological and early literacy specialists are available in teacher training colleges, pre-service educators note a distinct lack of integrated expertise in their institutions. Based on these findings, recommendations are given for research, policy and practice."

Ward, C. L. & Kushner Benson, S. N. (2010). Developing new schemas for online teaching and learning: TPACK. *Journal of Online Learning and Teaching, 6*(2). Retrieved from http://jolt.merlot.org/vol6no2/ward_0610.htm

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

Yesiltas, E. (2016). An analysis of social studies teachers' perception levels regarding web pedagogical content knowledge. *International Educational Studies, 9*(4), 108-123. doi: 10.5539/ies.v9n4p108

Abstract: "Web pedagogical content knowledge generally takes pedagogical knowledge, content knowledge, and Web knowledge as basis. It is a structure emerging through the interaction of these three components. Content knowledge refers to knowledge of subjects to be taught. Pedagogical knowledge involves knowledge of process, implementation, learning methods, and teaching methods. Web knowledge is about general Web competencies such as the use of tools related to the Web, Web-based communication, and Web-based interaction. The purpose of this study is to analyze social studies teachers' perception levels regarding Web pedagogical content knowledge. The population of the study covers social studies teachers in Turkey while the sample of the study covers 601 social studies teachers who were randomly selected from 75 cities of Turkey in 2015. Data collection tool employed in this study is Web Pedagogical Content Knowledge Scale composed of 30 items and five factors, developed by Lee, Tsai, and Chang (2008), and adapted to the Turkish language by Horzum (2011). Data analysis of

the study was conducted via IBM SPSS Statistic 23 package. The findings were analyzed based on arithmetic mean, standard deviation, Mann-Whitney U test, and Kruskal-Wallis test. The significance of the data was evaluated at a significance level of 0.05. The results indicate that social studies teachers' perceptions regarding Web pedagogical content knowledge are high. The results also show that they consider themselves competent in this matter, and their perceptions regarding Web pedagogical content knowledge significantly vary by gender, the Department of graduation, and experience of using computers whereas they do not significantly differ by educational background and status of having a computer."

Book

Niess, M. L., Driskell, S. O., & Hollebrands, K. F. (2016). *Handbook of research on transforming mathematics teacher education in the digital age*. Hershey, PA: IGI Global. doi:10.4018/978-1-5225-0120-6

Abstract: "The digital age provides ample opportunities for enhanced learning experiences for students; however, it can also present challenges for educators who must adapt to and implement new technologies in the classroom. The *Handbook of Research on Transforming Mathematics Teacher Education in the Digital Age* is a critical reference source featuring the latest research on the development of educators' knowledge for the integration of technologies to improve classroom instruction. Investigating emerging pedagogies for preservice and in-service teachers, this publication is ideal for professionals, researchers, and educational designers interested in the implementation of technology in the mathematics classroom."

Chapters

Dick, T. P., & Burrill, G. F. (2016). Design and implementation principles for dynamic interactive mathematics technologies. In M. Niess, S. Driscoll, & K. Hollebrands (Eds.), *Handbook of research on transforming mathematics teacher education in the digital age* (pp. 23-51). Hershey, PA: IGI Global. doi: 10.4018/978-1-5225-0120-6.ch002

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."

Edson, A. J., & Thomas, A. (2016). Transforming preservice mathematics teacher knowledge for and with the curriculum: The case of digital instructional materials. In M. Niess, S. Driscoll, & K. Hollebrands (Eds.), *Handbook of research on transforming mathematics teacher education in the digital age* (pp. 215-240). Hershey, PA: IGI Global. doi: 10.4018/978-1-5225-0120-6.ch009

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."

Felger, J., & Shafer, K. G. (2016). An algebra teacher's instructional decision-making process with GeoGebra: Thinking with a TPACK mindset. In M. Niess, S. Driscoll, & K. Hollebrands (Eds.), *Handbook of research on transforming mathematics teacher education in the digital age* (pp. 493-518). Hershey, PA: IGI Global. doi: 10.4018/978-1-5225-0120-6.ch019

Abstract: "This chapter shares results of a classroom-based action research study on instructional decision-making when teaching a unit on linear functions with GeoGebra, a dynamic algebra environment. The TPACK / Student Knowledge Matrix developed by provided a structure for unit planning and lesson development. The matrix combines the three categories of teacher knowledge – technological, pedagogical, and content – with four levels of student knowledge – declarative, procedural, schematic, and strategic. While implementing the four-week unit, the algebra teacher used multiple data sources to document day-to-day decision-making. Data analysis revealed decisions were guided by the need to improve clarity, to increase interactivity, to highlight connections between representations, and to use GeoGebra as a tool to increase understanding. Throughout the unit, GeoGebra became a tool for computation, transformation, data collection and analysis, and error checking."

Flores, A., Park, J., & Bernhardt, S. A. (2016). Learning mathematics and technology through inquiry, cooperation, and communication: A learning trajectory for future mathematics teachers. In M. Niess, S. Driscoll, & K. Hollebrands (Eds.), *Handbook of research on transforming mathematics teacher education in the digital age* (pp. 324-352). Hershey, PA: IGI Global. doi: 10.4018/978-1-5225-0120-6.ch013

Abstract: “This chapter describes an empirical study aimed to design, implement, and refine a learning trajectory for developing future mathematics teachers' Technological Pedagogical Content Knowledge (TPACK). The learning trajectory is set in an instructional context where mathematics and technology are learned through inquiry, cooperation, communication, and modeling early in the teacher preparation program with the intent to establish a classroom model of instruction. The chapter focuses on preservice teachers' learning in two dimensions of TPACK. One dimension is the extension of preservice teachers knowledge to each one of the four principal components of TPACK: Overarching conceptions, Students understanding and thinking, Curriculum and curricular materials, and Instructional strategies and representations for teaching. The second dimension is along preservice teachers' progression in the five levels of adoption of technology: Recognizing, Accepting, Adapting, Exploring, and Extending. The learning trajectory is based on research and theory for learning mathematics in a meaningful way.”

Harrington, R. A., Driskell, S. O., Johnston, C. J., Browning, C. A., & Niess, M. L. (2016). Technological pedagogical content knowledge: Preparation and support of mathematics teachers. In M. Niess, S. Driscoll, & K. Hollebrands (Eds.), *Handbook of research on transforming mathematics teacher education in the digital age* (pp. 1-22). Hershey, PA: IGI Global. doi:10.4018/978-1-5225-0120-6.ch001

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.”

Marshall, A. M. S., & Callahan, K. M. (2016). Mathematics teacher educators’ TPACK and MKT knowledge domains: Designing online discussion blogs. In M. Niess, S. Driscoll, & K. Hollebrands (Eds.), *Handbook of research on transforming mathematics teacher education in the digital age* (pp. 353-381). Hershey, PA: IGI Global. doi:10.4018/978-1-5225-0120-6.ch014

Abstract: “In this chapter, two Mathematics Teacher Educators (MTEs) describe a study that examined the ways that they drew upon their knowledge domains, grounded in the TPACK framework and the Mathematical Knowledge for Teaching (MKT) framework, to design and utilize online discussion blogs as instructional tools to enhance preservice elementary teachers' learning of geometry and measurement. The findings indicate that more attention is warranted on the interrelationships between TPACK and MKT knowledge domains, specifically when MTEs

engage in collaborative planning. This work is significant because it illuminates the need for further coding granularity consideration driven by the complexities resident in the construct of Pedagogical Content Knowledge, when analyzing MTEs' engagement with mathematics activities that use technology."

McBroom, E. S., Jiang, Z., Sorto, M. A., White, A., & Dickey, E. (2016). Dynamic approach to teaching geometry: A study of teachers' TPACK development. In M. Niess, S. Driscoll, & K. Hollebrands (Eds.), *Handbook of research on transforming mathematics teacher education in the digital age* (pp. 519-550). Hershey, PA: IGI Global. doi:10.4018/978-1-5225-0120-6.ch020

Abstract: "Secondary geometry teachers from several urban school districts participated in a two-year professional development focused on integrating dynamic geometry into teaching. The chapter documents the positive impact of the professional development for teachers' Technological Pedagogical Content Knowledge (TPACK) development and their students' achievement in geometry through the use of the dynamic geometry approach. Instruments used to develop and assess teachers' TPACK included a Conjecturing-Proving Test, interviews and observation protocols. Participants' TPACK levels were identified using a TPACK Development Levels Assessment Rubric. Findings show that teachers' TPACK tended to remain within the three middle TPACK levels (accepting, adapting, and exploring). Recommendations and suggestions for future research are offered to those who implement school-based, mixed methods research studies involving technology."

Milner-Bolotin, M. (2015). Technology-enhanced teacher education for [the] 21st century: Challenges and possibilities. In X. Ge, D. Ifenthaler, & J. M. Spector (Eds.), *Emerging technologies for STEAM education* (pp. 133-153). New York: Springer. doi: 10.1007/978-3-319-02573-5_8

Abstract: "Science, Technology, Engineering, Art and Mathematics (STEAM) education goals have transformed dramatically during the last half of the century. Presently, they include developing an appreciation of the beauty and wonder of science; possessing sufficient knowledge to engage in public discussions; becoming careful consumers of information; learning about STEAM inside and outside school; and having the skills to enter careers of their choice, including, but not limited to STEAM. Unlike their 20th century predecessors who were exploring if and how technology might enter the public education realm, modern educators focus on how technology can address these goals. At the same time, the preparation of future STEAM teachers hasn't always kept pace with the changing technology-rich educational landscape. Teachers can barely keep up with technological innovations and often end up placing the pedagogical aspects of technology engagement on the back burner. New educational goals coupled with new educational technologies should be reflected in how we prepare STEAM teachers. This chapter attempts to re-conceptualize the engagement of STEAM teacher-candidates with technology during their formative years in order to help them meet these rapidly changing goals. To make the argument more meaningful, we use an example of a physics methods course in which an instructor modeled technology-enhanced active

engagement pedagogy and teacher-candidates were able to experience this learning environment both as students and as future teachers. The chapter also discusses the impact of this course on teacher-candidates' Technological Pedagogical Content Knowledge (TPCK), their attitudes about science teaching and learning, and their pedagogical decision-making during the practicum."

Niess, M. L., & Gillow-Wiles, H. (2016). Mathematics teachers' knowledge-of-practice with technologies in an online masters' program: Scoop action research experiences and reflections. In M. Niess, S. Driscoll, & K. Hollebrands (Eds.), *Handbook of research on transforming mathematics teacher education in the digital age* (pp. 463-492). Hershey, PA: IGI Global. doi:10.4018/978-1-5225-0120-6.ch018

Abstract: "As teacher education leverages online instructional environments, an important research focus is how best to re-conceptualize mathematics inservice teacher classroom observations. This chapter proposes an alternative methodology to the structure of traditional observations, where the Scoop Notebook provides a window into mathematics teachers' Technological Pedagogical Content Knowledge (TPACK), specifically their TPACK-of-practice. In this descriptive, cross-case study, a re-designed Scoop process frames teachers' engagement in classroom practices, putting into practice their scholarly formal knowledge and developing in-depth, rich reflections from their classroom actions and artifacts. This study illustrates how embedding the Scoop process into a graduate instructional strategies course as part of a Master's degree curriculum results in engaging teachers in action research where they use artifacts as objects to think with for transforming their TPACK for integrating technologies in teaching mathematics."

Orrill, C. H., & Polly, D. (2016). Developing teachers' TPACK for mathematics through professional development: The case of InterMath. In M. Niess, S. Driscoll, & K. Hollebrands (Eds.), *Handbook of research on transforming mathematics teacher education in the digital age* (pp. 433-462). Hershey, PA: IGI Global. doi:10.4018/978-1-5225-0120-6.ch017

Abstract: "In this chapter, InterMath is introduced as a learner-centered professional development environment that supports the development of Technological Pedagogical Content Knowledge (TPACK). Evidence will be presented from the research and evaluation on InterMath to highlight some of the ways in which InterMath has been successful. Vignettes provide examples of a typical conversation in a TPACK professional development environment. An analysis of findings indicates that the InterMath project contributed to teachers' TPACK development, with a focus on teachers' knowledge of technology and content (TCK). The knowledge and skills of the professional development facilitator was a key factor in the teachers' development. Implications for the design of professional development include simultaneously developing teachers' integrated knowledge of technology, pedagogy, and content."

Polly, D., Martin, C., Wang, C., Lambert, R. G., Pugalee, D. K., & Middleton, C. W. (2016). The influence of professional development on primary teachers' TPACK and use of formative assessment. In M. Niess, S. Driscoll, & K. Hollebrands (Eds.), *Handbook of research on transforming mathematics teacher education in the digital age* (pp. 382-405). Hershey, PA: IGI Global. doi:10.4018/978-1-5225-0120-6.ch015

Abstract: "Formative assessment continues to be heralded as a high-leverage teaching practice that has empirical links to student achievement. This chapter describes the design and influences of a year-long professional development project focused on supporting primary grades teachers with formative assessment skills in mathematics. The professional development was a blended format that included face-to-face workshops as well as classroom-based activities that were presented and facilitated through an online asynchronous format. Findings from the study indicated that teachers' enacted evidence of various aspects of TPACK, but there was variance in terms of how teachers implemented pedagogies. Implications for the design of professional development focused on formative assessment include the need to situate teachers' learning in their classroom, and provide ongoing multiple modes of support to help teachers enact formative assessment practices."

Smith, N. J, & Bhattacharya, K. (2013). Practical wisdom of tool and task: Meeting the demands of the method with digital tools in qualitatively driven mixed methods studies. In S. Hai-Jew (Ed.), *Enhancing qualitative and mixed methods research with technology* (pp. 210-230). Hershey, PA: IGI Global. doi: 10.4018/978-1-4666-6493-7.ch009

Abstract: "The purpose of this chapter is to explain the effective use of digital tools to display and analyze mixed methods data and to identify the challenges and possibilities of doing a qualitatively driven mixed methods study of technology use in education. To frame this chapter, examples from a qualitatively driven mixed methods study of doctoral students, which explored how the use of mobile technology affected engagement in the class experience, are presented. Additionally, the authors discuss the limits, implications, and possibilities of inductively driven mixed methods, while dealing with issues of academic rigor and trustworthiness using Morse and Niehaus's (2009) guidelines for mixed methods research design and the ways in which digital tools enhance rigor and trustworthiness."
Editors' note: The TPACK construct was used to analyze qualitative and quantitative data in the study described in this chapter.

Wiburg, K., Chamberlin, B., Trujillo, K., Parra, J. L., Stanford, T. (2016). Transforming mathematics teaching through games and inquiry. In M. Niess, S. Driscoll, & K. Hollebrands (Eds.), *Handbook of research on transforming mathematics teacher education in the digital age* (pp. 52-77). Hershey, PA: IGI Global. doi:10.4018/978-1-5225-0120-6.ch003

Abstract: "This chapter describes the design, development, and testing of a successful mathematics game-based intervention, Math Snacks, for students in grades 3–7. This program shows the impact of an integrative approach of developing Technological Pedagogical Content

Knowledge (TPACK), where interactive digital media are combined with inquiry-based activities in classrooms facilitated by teacher involvement. Teachers played a key role in development and testing of Math Snacks, both by using them in their classrooms and by teaching core mathematics concepts connected to each module during annual summer camps. Via this multi-faceted participation, teachers experienced a change in their understanding of how digital tools can connect with inquiry-based pedagogy, mathematical content and pedagogical knowledge to facilitate successful learning for students. Teachers began to approach multimedia and games as part of an inquiry-based pedagogical approach for mathematics learning, rather than seeing games as tools for student practice after learning a concept."

Wright, V. H. & Davis, A. (2016). Integrating technology in nurse education: Tools for professional development, teaching, and clinical experiences. In V. C. X. Wang (Ed.), *Leadership and personnel management: Concepts, methodologies, tools, and applications* (pp. 728-743). Hershey, PA: IGI Global. doi:10.4018/978-1-4666-9494-1.ch002

Abstract: "This chapter explores how nurse educators can better integrate technology in their professional development, teaching and learning, and clinical experiences in a purposeful and meaningful manner. The authors explore how and why nurse educators should be mindful of the intersection of technology, pedagogy, and content knowledge (TPACK) in developing teaching and learning plans. The authors contend that nurse educators should consider and employ TPACK on a routine basis, so that using technology purposefully becomes the traditional approach in one's teaching. Examples of how technology can become more meaningful in three areas that nurse educators routinely work within are: professional development, teaching, and clinical experiences."

3. Recent TPACK-Related Dissertations

Brown, S. M. (2016). *Interactive whiteboards and TPACK for technology-enhanced learning: Secondary mathematics teachers' barriers, beliefs, and support needs in one rural school district* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 3737130)

Abstract: "Low-income students and blacks make up nearly half of public school students, and on nearly every indicator of educational access, particularly technology, these students have less access than white affluent students (Darling-Hammond, Zielezinski, and Goldman, 2014). The National Center for Education Statistics (2005) reported that teacher quality and missed opportunities to learn accounted for 93% of African Americans, and 87% of Hispanics performing below proficiency in mathematics. Students that do not master mathematics standards by the end of compulsory education are less likely to complete general mathematics courses in upper secondary school and beyond successfully (Levpušek, Zupani, & Soan, 2013). Interactive whiteboards (IWBs) can support student engagement, interest and possibly increased achievement in mathematics if used effectively. "

The purposes of this study were to (a) examine the perspectives of secondary mathematics teachers with regard to the use of IWBs for teaching, (b) determine how secondary mathematics teachers in one school district use the IWB to guide students toward mathematical proficiency, and (c) consider how secondary mathematics teachers' perspectives in one school district were influenced by 1 st order and 2nd order barriers to technology integration. The following factors were considered when examining the context needed to better understand the complexities using IWBs effectively in mathematics: (a) Niess et al. (2009) Mathematics Teachers' TPACK Development Model, (b) Miller and Glover (2005) stages of IWB use, and (c) Ertmer (1999) first-order and second-order barriers to technology integration.

The data revealed that at each stage of IWB use (a) *supported didactic,* (b) *interactive,* and (c) *enhanced interactivity,* teachers faced a unique combination of first-order and second-order barriers to IWB integration that affected how IWBs were used for teaching mathematics. The results of the data suggest that as barriers are resolved at each stage of IWB use, the likelihood mathematics teachers will effectively use IWBs to teach mathematics will increase. Suggestions including administrator support and modifying professional development practices are included to provide educators and policy makers the practical knowledge needed to inform sustainable plans for integrating IWBs effectively."

McKeown, P. T. (2016). *Determining the impact of educational technology professional development on 8th grade students' 2009 reading achievement* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 10098952)

Abstract: "The purpose of this study was to examine the influence of professional development for utilizing technology in the classroom on student achievement on the 8th grade Reading National Assessment of Educational Progress (NAEP). A similar study was conducted to determine the influence of educational technology professional development on 4th grade students' mathematics achievement. The 2013 study concluded that teachers who had access to technology in their classrooms and more frequently participated in educational technology professional development, had students with higher achievement on the NAEP mathematics assessment (Cavaliere, 2013). The current research study accesses similar variables from the 8th grade reading NAEP dataset and conducts a similar regression analysis to the 2013 4th grade mathematics study. The goal is to determine whether the eighth grade students achieve higher reading assessment scores when their teachers have had similar levels of educational technology professional development and access to technology in their classrooms, similar to their 4th grade mathematics counterparts."

4. Recent TPACK Presentations

Adam, A. (2016, April). *A framework for seeking the connections between technology, pedagogy and culture: A study in the Maldives.* Paper presented at the 2016 Distance Education Association of New Zealand Conference, Hamilton, New Zealand.

Abstract: “Educational technology researchers often overlooked the impact of culture on teachers’ use of digital technologies in their pedagogical practices. This also includes a number of technology integration models (e.g. TAM and TPACK) that have failed to explain the connections between technology, pedagogy, and culture. This paper argues that teachers’ pedagogical and technological practices cannot be fully understood without considering the social and cultural norms of their specific cultures. This study adopted an ethnographic methodology, linked with Bourdieu’s (1977) habitus as a lens for exploring teacher educators’ practices in the Maldives. Data were gathered from eleven teacher educators who work in a Maldivian university context: using interviews, observations, focus groups and the hanging out approach. Key findings demonstrated that teacher educators’ pedagogical and technological practices were influenced by their own culture, early learning experiences in the Maldives, and their workplace (institutional context). Through this finding, this research proposes a framework, namely, Pedagogical and Technological Cultural Habitus (PATCH) for understanding teachers’ pedagogical and technological habitus in various contexts. The PATCH framework is, theoretically useful for designing technology-oriented professional development for professionals in various pedagogical contexts including virtual and blended pedagogical spaces. It also contributes to TPACK framework by adding an outer layer to its current theorisation to represent teachers’ backgrounds and habitus when examining their practices.”

Aydin, G. C., Evren, E., Atakan, I., Sen, M., Yilmaz, B., Pirgon, E., …Ebren, E. (2016). Delphi technique as a graduate course activity: Elementary science teachers’ TPACK competencies. *SHS Web of Conferences, 26*. doi:10.1051/shsconf/20162601135

Abstract: “This study aims to explore graduate science education students’ views of elementary science teachers’ TPACK competencies by employing a Delphi technique. 9 graduate science education students enrolled in a graduate course participated in the study. In the first round, participants were asked to list the competencies of an elementary science teacher with high level of TPACK and a total of 88 competencies were listed. In the second round, all participants investigated these competencies and eliminated the similar ones. In the third round, the number of competencies was narrowed down to 35 and participants rated them on a 7-point Likert type scale. In the fourth round, participants investigated the interquartile range and median values for those competencies, their own previous ratings and rated the competencies again. At the end, a total of 29 competencies were agreed on by all participants. For agreement criteria interquartile range and median values were used.”

Log, I. B., & Swensen, H. (2015, March). *Flipped classroom as a stepping stone for integrating TPACK mindset in teacher education*. Paper presented at the 9th International Technology, Education, and Development Conference, Madrid, Spain.

Abstract: “Research shows that in spite of that Norway has one of the highest concentration[s] of computers in schools and that national guidelines emphasizes the use of digital tools to support learning, Norwegian teachers do not yet utilize the potential that digital tools offers.

The 21st century teacher[s] are expected to use digital tools in order to enhance learning. To achieve this, educators in teacher education must be role models in regards to integration of technology in education. Teacher educators must therefore have a solid grasp of the potential digital tools gives and how to use it in their own teaching.

In this paper, we analyze results from an ongoing project to enhance digital literacy for educators in teacher education. We will look at dissemination of the method flipped classroom in teacher education to examine its impact on educators' digital didactical competence.

The project was conducted in [the] second half of 2014. The participants were educators of different background as of disciplines and digital competence. The project consisted of a presentation of flipped classroom, followed by workshops. The main goal was to expand the educators' digital didactic competence by closer integrating the technological dimension in their didactical practice.

The empirical material consists of interviews and a survey from the process of disseminating flipped classroom. The theoretical framework for this project is based on Mishra and Koehler's TPACK-model, which present the correlation between Technological, Pedagogical and Content Knowledge.

The results at this point indicate that the participants are interested in expanding their didactical practice by the integration of technology, and this interest is present across multiple disciplines. However, some are hesitant to use new technology, when it challenges their traditional view of student-teacher dialogue.

Our preliminary conclusion is that the participants are eager to utilize technology to expand their didactical repertoire. Their experience through this project with flipped classroom as a digital didactical method increased their digital competence. It remains to be seen whether this leads to a change of practice, but it seems that the participant didactical focus are moving closer to the center of the TPACK-model."

Lomax, E. C. (2016, April). *Technology integration and teacher education: Learning with technology* [Slides]. Presented at the Pedagogie, Didactique et TICE (PeDTICE) Colloquium, Montreal, Canada. Retrieved from http://www.slideshare.net/e_lomax/technology-integration-and-teacher-education-learning-with-technology

Abstract: "This presentation discusses the Technological Pedagogical Content Knowledge (TPACK) model, explores the affordances and constraints that are commonly associated with the integration educational technology into teacher education curricula in general, and highlights the relationship of relevant aspects of the TPACK model and technology integration debate that are likely to affect the future design goals and instructional objectives guiding the further development of pre-service teacher educational technology courses similar to EDM 310; a required undergraduate course in the teacher education program in the College of Education

at the University of South Alabama that explores the use and integration of educational technology to support K-12 classroom instruction and student learning."

Mangan, J., Forret, M., & Buntting, C. (2015, November). *Enhancing technology teachers' use of web-based resources: Using TPACK as a tool for communication and analysis.* Paper presented at the Technology Education New Zealand (TENZ) Conference, Hamilton, New Zealand. Retrieved from http://tenzcon.org/wp-content/uploads/2016/02/Mangan-WBRs.pdf

Abstract: "Technology education has unique resourcing needs, some of which can be conveniently and often more effectively met by web-based resources (WBRs) than by paper-based resources or even direct contact with communities of practice. However, despite the acknowledged potential of the Internet to transform education, and increasing access to, and use of, WBRs in schools, teachers are not necessarily well prepared to integrate them effectively into their pedagogy. This is not surprising given the range of specialised knowledge that effective integration requires – what Koehler and Mishra (2009) have called technological pedagogical content knowledge (TPACK). The context for this paper is a research project in which seven experienced secondary technology teachers participated in a sustained professional development programme aimed at enhancing their integration of WBRs into their technology programmes. The study employed an interpretive research design and qualitative research methods, and was underpinned by sociocultural theoretical perspectives. The focus of the paper is on how the TPACK framework was used as a tool to facilitate communication of theoretical ideas about effective integration of WBRs, and to analyse the teachers' developing knowledge as they tried out new approaches in the classroom."

Millen, R. A., & Gable, R. (2015, April). *Closing the gap between technological and best practice innovations: TPACK and DI.* Paper presented at the annual meeting of the New England Educational Research Organization, Portsmouth, New Hampshire. Retrieved from http://scholarsarchive.jwu.edu/k12_ed/33

Abstract: "Implementing differentiated instruction with the fast changing landscape of technology is a complex process (Fullan, 2014; Tomlinson; 2014) and requires widespread diffusion of multiple innovations by educators (Meyer, 2004). However, most U.S. classrooms remain stagnant in their attempts to successfully incorporate innovative pedagogies (Darling-Hammond, 2010; November, 2014; Prensky, 2010; Robinson, 2011). Thus Fullan (2014) reported, "The time is right to bring together knowledge of systems change, new pedagogies and technologies that allow change to scale through diffusion" (p. 13).

To understand this problem, this pragmatic, mixed-methods study (Creswell, 2009) collected data through the following condensed research questions: What are the relationships between educators' TPACK and DI self-efficacy and the following demographics: grade level, years of teaching, adopter category, device-student ratio, professional development hours in technology or DI, class size, certification(s), and educational background? How do teachers describe their use of technology to differentiate instruction?

A questionnaire with open-ended questions provided quantitative and qualitative data (N=72). Of the respondents, 22% were categorized as innovators and 32% as early adopters-considered teacher leaders. Even though both groups demonstrated more confidence with DI-T than later adopter categories, neither showed significantly stronger TPACK. However, Grade 8-12 teachers demonstrated significantly higher TPACK and self-efficacy to DI than pre-kindergarten to grade 4 teachers.

Qualitative themes confirmed the problem. Educators demonstrated misconceptions of TPACK and self-efficacy to DI, and these innovative practices were not successfully being diffused. Thus, recommendations identified specific professional development needs, and for educational systems to create communication channels to more rapidly diffuse innovational pedagogies."

Millen, R. A., & Gable, R. (2015, April). *New era of teaching, learning, and technology: Teachers' perceived technological pedagogical content knowledge and self-efficacy towards differentiated instruction.* Paper presented at the annual meeting of the New England Educational Research Organization, Portsmouth, New Hampshire. Retrieved from http://scholarsarchive.jwu.edu/k12_ed/34

Abstract: "Shifting from an industrial model of education to a model that best provides students with differentiated instruction (Tomlinson, 2014) requires educational philosophical change (Fullan, 2014) as well as innovation diffusion (Rogers, 2003). The problem is not the amount of research that exists on differentiation, the diffusion of innovations, or the change process. The problem is what new technological pedagogical content knowledge (Koehler & Mishra, 2008) do educators need to make this change process happen? How is this knowledge communicated to finally change the "fundamental processes of schooling" (Elmore, 1996, p. 4)?

This sequential, mixed-methods study addressed the following condensed research questions: What are in-service teachers' perceived knowledge levels in relation to technological pedagogical content knowledge (TPACK)? What are teachers' perceived levels of comfort to differentiate instruction (DI)? Is there a significant relationship among perceived levels of comfort to DI and TPACK? What are the relationships between educators' TPACK and DI self-efficacy and the following demographics: grade level, years of teaching, adopter category, device-student ratio, professional development hours in technology or DI, class size, certification(s), and educational background?

A questionnaire with open-ended questions provided quantitative and qualitative data (N=72). On a 5-point (SD – SA) Likert scale, pre-kindergarten to grade 12 teachers self-perceived TPACK ranged from 3.46 to 4.00. The educators' self-efficacy to DI (5- point; Not Confident-Very Confident) was 4.01 and DI with technology (DI-T) was 3.16. Grade 8-12 teachers demonstrated significantly higher TPACK and self-efficacy to DI than pre-kindergarten to grade 4 teachers.

Of the respondents, 22% were categorized as innovators and 32% as early adoptersconsidered teacher leaders. Both groups demonstrated more confidence with DI-T than later adopter categories. Even with significant correlation between TPACK and DI ($r=.47$, $r^2= .22$; $p < .001$),

TPACK and DI modeling ranged from 2.20 (teachers) to 1.75 (teacher leaders) and from 2.32 to 2.03 respectively (1=25% or less to 4=76-100%).

Qualitative themes confirmed the problem. Even though TPACK and self-efficacy to DI were relatively strong, these innovative practices were being rejected. Thus, recommendations identified specific professional development needs, and for educational systems to create communication channels to more rapidly diffuse innovational pedagogies."

Ouyang, F. (2015, July). T*he design of a completely online undergraduate-level course and the application of technological pedagogical content knowledge in the online course.* Paper presented at the 7th International Conference on Education and New Learning Technologies, Barcelona, Spain.

Abstract: "This paper proposes my self-report about the design a completely online course and the exploration of the potentials of applying Technological Pedagogical Content Knowledge (TPACK) to facilitate a completely online course. This course is an undergraduate-level online course on Computer Foundations and Applications in a comprehensive central south university in China. The primary purpose of this study is to explore the potentials of applying TPACK to facilitate a completely online course and to build an effective online learning community in a Chinese university.

The fundamental element that makes the online learning different from the traditional face-to-face instruction is the process of interaction, communication and collaboration in the online learning environment. In my online course design, all online learning activities of this course are conducted in a Chinese online learning community -- China Education Online. This online learning community has various functions such as discussion forum, blog, group, online courses that could help instructors to develop constructivist teaching and learning. This online social learning community allows learners to interact and collaborate with each other through using rich synchronous and asynchronous communication tools, management tools, publishing and diffusion tools. The collaborative activities and group discussions help increase the level of communication and interaction among learners and enable to form a learner-focused, active learning process (Palloff & Pratt, 2007).

In addition to the online course design, I explore how to apply TPACK to design this online course, to create the online learning environment and to form an online learning community. TPACK contains three main knowledge domains (Content, Pedagogy, and Technology) and the four intersecting knowledge areas : PCK (pedagogical content knowledge), TCK (technological content knowledge), TPK (technological pedagogical knowledge), and TPCK (technology, pedagogy, and content knowledge). Around these seven elements is the context, which is formed by learners, the instructor, and other influential factors (Koehler, Mishra, & Cain, 2013). With the purpose of motivating and engaging students in the online course, I will discuss the application of the seven TPACK components on the holistic design of the online learning environment and the online learning community, and the detailed online course curriculum design. Online course curriculum design will contain all contents such as syllabus, class agendas,

discussion postings, and resources. More importantly, I will explore how to integrate these contents with various technologies in the online learning platform in order to motivate and engage students and form an online learning community among students."

Saraswathy, R. (2016, February). *Technological pedagogical content knowledge in the mathematics classroom.* Paper presented at the National Conference on Higher Education in the Knowledge Age: Techno-Pedagogical Perspectives and Innovations, Tiruchirappalli, Tamil Nadu, India.

Abstract: "Technological pedagogical content knowledge is an understanding that emerges from interactions among content, pedagogy, and technology knowledge. Underlying truly meaningful and deeply skilled teaching with technology, TPACK is different from knowledge of all three concepts individually. Instead, TPACK is the basis of effective mathematics teaching with technology, requiring an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones. The working technology knowledge of a mathematics teacher using graphing calculators, computer software programs, and computer-based laboratories to deeply explore a mathematical topic is vastly different than that of an English teacher using the Internet and software programs to investigate and prepare literary documents. Each content area has specific instructional goals and needs that technology can address in a variety of ways."

Xazela, M. W., Mbodila, M., Seaba, T., & Mutshaeni, N. (2015, November). *"Molo songololo": A cooperative approach to technology integration for teaching using the TPACK model at a rural university in South Africa.* Paper presented at the 8th International Conference of Education, Research, and Innovation, Seville, Spain.

Abstract: "Technology for teaching and learning has been adopted for many years by most institutions in South Africa, but some rural institutions have been behind as a result of not having the necessary IT Infrastructure, skills and factors originating from the past where institutions in Previously Disadvantaged areas were underfunded. However, the use of technology for teaching provides new practices for teachers to engage learners in their teaching process and there is a challenge in how teachers can incorporate pedagogy in the use of technology in the classroom for teaching. Research has demonstrated that Technology, Pedagogy and Content Knowledge (TPACK) has been used as a theoretical lens which identifies the nature of knowledge required by teachers for technology integration in their teaching. This study reports on experiences during the integration process in consideration of the skills of academic staff and their working environment. Academic staff were asked to critically evaluate the current state of the courses they are teaching using the SWOT analysis approach to identify areas that can be possibly improved by using Technology, specifically a Learning Management System (LMS). The analysis was done at the beginning of a semester, a strategy was formulated

to tackle the identified challenges using TPACK Model and again mid-semester an evaluation was done to determine progress and the necessary support was continuously given as the way forward. The TPACK Model approach is used to find the solution to encountered problems."

5. Recent TPACK-related Blog Entries

Baran, E. (2016, April 5). Putting technological, pedagogical, and content knowledge (TPACK) in action: An integrated TPACK-design-based-learning (DBL) approach. [Web log post]. Retrieved from http://blog.metu.edu.tr/ebaran/

Editors' Note: This blog entry summarizes the author's article with the same title in this issue.

Excerpt: "Design-based learning (DBL) has been considered a useful approach in teacher education because of its emphasis on the investigation of technology integration problems in design processes. Despite recent interest in understanding how technological, pedagogical, and content knowledge (TPACK) translates to action, limited research exists on how TPACK is developed within DBL contexts and what principles of DBL can be applied to TPACK development. To address these critical gaps in the literature, an approach was developed that outlined eight DBL principles that foster understanding of TPACK-in-action in teacher education contexts. Next, a graduate course was designed to determine how course activities facilitated understanding of TPACK-in-action and to what extent students enacted TPACK-DBL principles. Following a case study methodology, data were collected from 10 graduate students through reflection reports, design guides, and researcher observation notes. The analysis of qualitative and descriptive data revealed that as a result of TPACK-DBL activities, students developed a four-dimensional understanding of TPACK-in-action: theory-practice connection, readiness for practice, technological proficiency, and sustainable learning of TPACK. The results offer recommendations to teacher educators for developing understanding of TPACK-in-action through DBL activities."

6. 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., & Rodriguez, K. (Eds.). (2016, May 5). TPACK newsletter issue #28: May 2016 [Electronic mailing list message]. Retrieved from http://www.matt-koehler.com/tpack/tpack-newsletters/

7. 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/
- 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

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.news.editors@wm.edu.

Standard End-Matter

If you have questions, suggestions, or comments about the newsletter, please send those to tpack.news.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 & Kim

…for the SITE TPACK SIG leadership:

Josh Rosenberg,	Co-Chair, Michigan State University
Mamta Shah,	Co-Chair, Drexel University
Petra Fisser,	Red-Blue Chair, SLO Expertise Center, National Curriculum Development
Candace Figg,	Rocking Chair, Brock University
Mark Hofer,	Sedan Chair, College of William & Mary
Judi Harris,	Wing Chair, College of William & Mary
Mario Kelly,	Futon, City University of New York
Matt Koehler,	Chaise Lounge, Michigan State University
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