TPACK Newsletter, Issue #44: March 2021

Welcome to the long-awaited(!) 44th edition of the TPACK Newsletter! TPACK work is continuing worldwide. This document contains updates to that work that have not yet appeared in previous issues of this newsletter. We hope that these contents 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

"Knowledge is not a series of self-consistent theories that converges toward an ideal view; it is rather an ever-increasing ocean of mutually incompatible (and perhaps even incommensurable) alternatives. Each single theory, each fairy tale, each myth that is part of the collection forcing the others into greater articulation and all of them contributing, via this process of competition, to the development of our consciousness."
- Paul Feyerabend

In This Issue

1. TPACK Newsletter Update

The TPACK Newsletter has been published via the tpack.news email list since January 2009. It has **1217 subscribers** currently. Subscription numbers have held steady (+ or – 1% to 3%) since October 2011.

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

Articles: 1418   **Chapters: 318**   **Books: 28**   **Dissertations: 438**

2. Invitation to Collaborate

The TPACK SIG is seeking volunteers for an ad hoc committee to assist in updating the [TPACK Wikipedia page](https://en.wikipedia.org/wiki/Technological_pedagogical_content_knowledge) (https://en.wikipedia.org/wiki/Technological_pedagogical_content_knowledge). For many practitioners, Wikipedia is a launching point for their initial inquiry on a topic before engaging in further research and exploration. Unfortunately, the TPACK Wikipedia page was deleted in 2017, and although it has since been restored, much of the information on the page is woefully outdated and is narrow in its coverage of TPACK content. Therefore, the TPACK SIG is organizing an ad hoc committee to remedy this issue so that TPACK can be more accessible to practitioners.

This is an international service opportunity is open to individuals with interest and/or expertise in TPACK, including both doctoral students and university faculty members. The committee will begin collaborating in January 2021 with the goal of sharing an update on their progress during the TPACK SIG Business Meeting at SITE 2021. We expect the committee's work to conclude in late May or early June 2021. If you or any of your colleagues or contacts are interested in participating, please sign up here: https://tinyurl.com/TPACKwikipedia. Questions can be directed to the TPACK SIG Co-Chairs, Daniel Mourlam (daniel.mourlam@usd.edu) and Yi Jin (yjin8@kennesaw.edu).

3. Recent TPACK Publications

Below are recent TPACK publications that we know about: **172 articles, 25 chapters, and 34 dissertations** that have not appeared in past issues of this newsletter. If you know of others that were published within the past several months, please let us know at: tpack.newsletter.editors@wm.edu.

Articles

Absari, N., Muslikhin, & Priyanto. (2020). The effectiveness of technology, pedagogy, and content knowledge (TPACK) in learning. *Jurnal Pendidikan Teknologi dan Kejuruan, 26*(1), 43-51. https://doi.org/10.21831/jptk.v26i1.24012

Abstract: "The study examined the factors affected teachers' Technology, Pedagogy and Content Knowledge (TPACK). Those factors are Technology Knowledge (TK), Pedagogy Knowledge (PK), Content Knowledge (CK) and Technology Pedagogy Knowledge (TPK). Curriculum 2013 has been applying for 5 years. However, an evaluation of how does the teacher deliver learning subjects (pedagogy knowledge), and the implementation of subject

mastery (content knowledge) and technology mastery (technology knowledge) is strongly suggested. The study was quantitative with an associative method involving 200 teachers in Salatiga region as samples drawn with simple random sampling. The results of the study showed that PK has a positive effect on TPACK, while TK and CK do not have a positive effect on TPACK. Furthermore, TK, TPK, PK have positive effects on TPK, and TPK has a positive effect on TPACK. This study also suggested that age influences the development of technological knowledge and if one of the knowledge is not possessed by a teacher, the learning process will achieve maximum outcomes."

Açıkgül, K. (2020). The effect of technological pedagogical content knowledge game activities supported micro-teaching practices on preservice mathematics teachers' self-efficacy perception. *Acta Didactica Napocensia*, *13*(2), 157-173. https://doi.org/10.24193/adn.13.2.11

Abstract: "The purpose of this study is to investigate the effect of Technological Pedagogical Content Knowledge (TPACK) Game activities supported micro-teaching practices on middle school preservice mathematics teachers' TPACK self-efficacy perception levels. A single group pretest-posttest experimental design was employed. One hundred middle-school preservice mathematics teachers, attending a mathematics instruction course, participated in the study. The Technological Pedagogical Content Knowledge Survey (Şahin, 2011) was used to determine teachers' level of TPACK-measured self-efficacy. One-way Repeated Measures ANOVA was performed to analyze possible differences between teachers' pre and post self-efficacy scores. The result of this analysis demonstrated a statistically meaningful difference for the overall survey as well as for all dimensions of it. These findings suggest that micro-teaching practices do indeed increase preservice teachers' TPACK self-efficacy perception scores."

Adov, L., Pedaste, M., Leijen, A., & Rannikmäe, M. (2020). Does it have to be easy, useful, or do we need something else? STEM teachers' attitudes toward mobile device use in teaching. *Technology, Pedagogy and Education*. Advance online publication. https://doi.org/10.1080/1475939X.2020.1785928

Abstract: "Studies show that technology can have a positive influence on student achievement and motivation; however, the use of technology for educational purposes is rather modest. Research has shown teachers' attitudes to be a key aspect of technology use. However, there is no agreement on which attitudes we should focus on. The aim of the present study was to determine which attitudes may be differentiated empirically in a sample of STEM teachers in the context of mobile devices in teaching and to what extent these factors help to predict willingness to use mobile devices. The study was conducted among 377 STEM-subject teachers. The results showed that performance expectancy, effort expectancy and technology attitude are highly correlated for teachers. It would appear that social aspects (social influence and facilitating conditions) may serve as facilitators for teachers' attitudes in the model, predicting 52.5% of teachers' behavioural intention to use mobile devices for teaching."

Aguilar, S. J. (2020). A research-based approach for evaluating resources for transitioning to teaching online. *Information and Learning Sciences, 121*(5/6), 301-310. https://doi.org/10.1108/ils-04-2020-0072

Abstract: "Purpose This paper provides a research-based approach for evaluating resources for transitioning to teaching online. Design/methodology/approach This paper uses Davies' (2011) discussion of technological literacy; Koehler and Mishra's (2009) Technology, Pedagogy and Content Knowledge (TPACK); Leacock and Nesbit's (2011) Learning Object Review Instrument; and Reynolds and Leeder's (2018) expanded notion of "technology stewardship" to underpin an approach that educators can use to evaluate educational resources for transitioning to teaching online. Findings This paper introduces and applies an approach focused on evaluating the source of a given educational resource, as well as how it can be implemented. Research limitations/implications This paper synthesizes frameworks relating to qualities of educational technologies and frameworks relating to qualities of educators, and introduces two criteria for evaluating resources for transitioning to distance learning. Practical implications This paper provides readily applicable criteria for evaluating resources in a time of emergency distance learning. Social implications This approach enables educators to evaluate resources in a time of emergency distance learning. Originality/value The synthesis of four approaches to evaluating educational technologies, and applying the approach to four resources that have emerged to address COVID-19-related instructional needs."

Ajloni, M., & O'Toole, M. (2021). Conceptualizing pedagogical processes in video-based learning. *LUMAT-B: International Journal on Math, Science and Technology Education*, *6*(1), 1–17. https://journals.helsinki.fi/lumatb/article/view/1496

Abstract: "Five pedagogical processes concerned with the usage of video technologies by teachers for educational purposes are conceptualized and presented. The pedagogical processes are a teacher's internal thinking processes when trying to involve VT in teaching and provide a pathway to a teacher's cognition in a holistic manner. These processes play affective, behavioral, and cognitive roles in video-based learning and involve the teacher's general role in the use of video technology (role awareness), their selection of videos for teaching (selection), choice of a learning environment for teaching (environment-fit), use of innovative technology for teaching (creative process) and the overall value attached to using VT for teaching (value attribution). The pedagogical processes presented are viewed through the lens of the TPACK theoretical framework and conceptualizes how an optimal pedagogical outcome can be achieved by their amalgamation."

Aktaş, İ., Özmen, H. Investigating the impact of TPACK development course on pre-service science teachers' performances. *Asia Pacific Education Review*, *21*, 667–682. https://doi.org/10.1007/s12564-020-09653-x

Abstract: "The aim of this study is to investigate the Technology Pedagogy and Content Knowledge (TPACK) development of pre-service science teachers (PSTs) who participated in a

TPACK Development Course (TPACK-DC) that consisted of three stages: a training course, lesson plans involving the application of micro-teaching, and school application. This study was carried out with six PSTs selected according to the appropriate sampling method. Semi-structured interviews, lesson plan reports, and video recordings of lesson presentations were used to follow the development of PSTs. At the end of the study, it was found that TPACK-DC contributed to the association of PSTs' Technological Knowledge (TK), Pedagogical Knowledge (PK), and Content Knowledge (CK), which eliminated deficiencies in these areas of knowledge, as well as in the understanding of TPACK. The TPACK-DC also promoted the use of information and communication technology (ICT) tools by PSTs. It helped to develop the knowledge required to choose suitable teaching methods using technology to teach the related subject matter, teaching said content correctly, applying skills to promote active participation by students, proper classroom management, and applying appropriate guidance while teaching science subjects with ICT tools."

Alava, W. G. (2020). Technological pedagogical content knowledge of College of Arts and Sciences professors. *Transdisciplinary International Journal of Academic Research*, *1*(1). http://tijarjournal.com/wp-content/uploads/2020/09/5th-Chapter-Wilfred-G.-Alava-Jr..pdf

Abstract: "The Technological, Pedagogical. Content Knowledge (TPACK) framework introduces the mixing of the 3 main domains (technological knowledge, pedagogical knowledge and Content knowledge). This study was designed to work out the amount of TPACK of the faculty of Arts and Sciences Professors of Bukidnon State University. This study could be a descriptive survey sort of analysis. There have been eighty Professors of the College of Arts and Sciences who participated the study. Associate tailored and changed form from Helmut Schmidt (2009) and Sahin (2011) was employed in gathering and grouping knowledge. Knowledge were subjected to applied math treatment. It had been noted that education data and Technological education data have the best mean score with a website level of professional. Generally, the TPACK domain of the CAS Professors is in Advanced level. This suggests that the TPACK domains were already integrated and enforced well by teaching content mistreatment applicable education strategies and technologies. They need associate intuitive understanding of the advanced interaction between the 3 basin parts of data (CK, PK, TK). Also, they're competent in to the data needed by professors for integration technology into their teaching in any content space. Moreover, there's no vital relationships between the demographic profile and also the TPACK of the CAS Professors. Hence, academics are expected to unceasingly develop their TPACK."

Ali, Z., Busch, M., Qaisrani, M. N., & Rehman, H. U. (2020). The influence of teachers' professional competencies on students' achievement: A quantitative research study. *American Research Journal of Humanities & Social Science*, *3*(6), 45–54. https://www.arjhss.com/wp-content/uploads/2020/06/F364554.pdf

Abstract: "This study aimed to assess the competency level of teachers' professional knowledge and technology integration and its impact on student's achievement in Karachi

Pakistan, for this purpose quantitative research design was employed and data was collected through a cross-sectional survey. Data was analyzed through SPSS and SMART PLS version 3.2.9. The data analysis revealed that teachers' professional knowledgeinterms of their teaching practices and Technology Integration has a positive significant impact on Students' Achievement. Secondly, teachers had a high perceptions and understanding of their self-professional development in terms of improvement in professional knowledge and technology integration. Teachers in this study had high scores on all three constructs of the model, indicating that they were able to perform, understand or know most of the activities indicated in the items of the questionnaire. this study also sought that teachers self-professional development in the different areas of professional knowledge i.e. technological knowledge, pedagogical knowledge and subject matter knowledge has a significant positive impact on students achievement as all the hypothesis of the current study were accepted.This investigation has uncovered how the qualities of teachers' TPACK move and change. Teachers' competency levels of three fundamental builds of TPACK has been seen an exceptional. The investigation has uncovered that teachers move their levels of TPACK to suit the relevant variables. Considering this, it will be appropriatethat more emphasisis laid on the significance of setting in the TPACK framework, and the entire constructs of TPACK ought to be implanted in the teaching learning."

Ali, Z., Thomas, M., Ahmed, N., Ahmed, I., & Ahmed, I. (2020). Assessment of preservice teachers' perceptions on technological pedagogical and content knowledge (TPACK) in Karachi Pakistan. *International Journal of Scientific & Engineering Research*, *11*(3), 1402-1407. https://www.citefactor.org/journal/pdf/Assessment-of-Pre-Service-Teachers-Perceptions-on-Technological-Pedagogical-and-Content-Knowledge-TPACK-in-Karachi-Pakistan.pdf

Abstract: "This is 21st century, an era of aligns standardized curriculum, advanced technologies and integrated knowledge. To meet the challenges of this changing world there is a need to enhance the certain core competencies of teachers such as collaboration, digital literacy, critical thinking, problem-solving and the knowledge of teaching and technology to achieve the goals of quality of education and students achievement. Technological Pedagogical and Content Knowledge (TPACK) is a technical framework of collective and composite knowledge required for teachers teaching practices in the classrooms with technology integration. This research focused on the professional knowledge of pre services teachers and their teaching practices with the use of technologies as contexts for the awareness of technology integration in teaching learning process. So in this study the perceptions of pre service teacher's level of understandings about TPACK and its related domains were assessed through cross sectional survey. The research reveals that all pre-service teachers have sound knowledge about TPACK, though their level is different, yet the value is insignificant statistically. The objective of the study was sought to explore the perceptions of pre service teachers' technological pedagogical content knowledge (TPACK), the relationship of its domains and the competency level of teachers' professional knowledge of technology integration at Elementary School level. A questionnaire based survey research design with purposive sampling was administered. The scale was used regarding, Technology knowledge (TK) Content

knowledge (CK) Pedagogical knowledge (PK) Pedagogical content knowledge (PCK) Technological content knowledge (TCK) Technological pedagogical knowledge (TPK) Technological pedagogical content knowledge (TPACK).Every scale was determined through different questions and a 5 point Likert scale was used in which 1 for strongly disagreed and 5 were for strongly agreed. The mean score 4.0 and above indicate that they were confident teachers and can easily use the technologies in their teaching according to the requirement of the day. The results of demographic information mean and St. Deviations shows that Out of total 290 teachers, 249(85.9%) were females and 41(14.1%) were males. The female male ratio was 1:0.17. According to age group distribution, majority i.e.59.6% was between the ages of 18-26 years. Out of these participants 76.6% were graduates and overall 64.8% were currently pursuing a degree of B.Ed. In Technology Knowledge, female technology knowledge mean was 3.51 to 3.72 whereas mean of male technology knowledge was 3.51 to 4.10. In content knowledge, the overall mathematics mean was 3.52 to 3.57. Although males mean was 3.54 to 3.80 but as males were in less in our study so that it did not make any effect on the overall conclusion mean. In pedagogical content knowledge, the highest percentage was in science and lowest was in mathematics, i.e. 72.1 to 63.7% who agreed or strongly agreed with the positive approaches in their field of studies. Technological pedagogical knowledge mean score of the replies was 3.72 to 4.10 which shows a good attitude of the teachers to adopt current technologies in their teaching performance according to the contents. Technology pedagogy and content knowledge mean score at this stage was extremely low from 3.52 to 3.75. Technology pedagogy and content knowledge mean score was extremely low from 3.52 to 3.75. This shows that either they were not confident on combination of all the things or they were un-cleared about the use of technology in each parable specially females."

Ali, Z., Thomas, M., & Hamid, S. (2020). Teacher educators' perception of technological pedagogical and content knowledge on their classroom teaching. *New Horizons*, *14*(2), 17-38. http://greenwichjournals.com/index.php/NH/article/view/430

Abstract: "Students of present era, usually pronounced as "digital natives," enter schools with an expectation that they will be engaged in an information and communication technology (ICT) enriched learning experience under some ICT-expert teachers. To meet students' expectations, teachers strive to enhance their knowledge of modern technology and teaching techniques that demand integration of technology in classroom teaching. However, there is a consensus among all stakeholders, that also includes policymakers, that teachers (as well as teacher educators) in Pakistan are poorly prepared and thus cannot meet the expectations of the "digital natives." This study is based on the pedagogical content knowledge (PCK) and technological pedagogical content knowledge (TPACK) framework, which measures educators' knowledge of effective teaching with technology. The model attempts to describe the type of effective teaching knowledge required by educators to implement technology integration in learning environments. By adopting a quantitative approach, the study analyzed the impact of teacher educators' knowledge of three elements of TPACK, that include, technological knowledge (TK), pedagogical knowledge (PK) and content knowledge (CK) on their classroom teaching. Using the survey method and two adopted questionnaires, data from all the teacher education institutes of public and private sector in Sindh, Pakistan were gathered. A total of 410 valid cases were

used to analyze data through the SPSS and the Smart PLS. The findings of the study reveal that all three elements of TPACK have a significant positive impact on teacher educators' classroom teaching, this shows that it enhances students' achievement and the quality of education. The study recommends that administrators, policymakers and educational stakeholder, align teacher educators' continuing professional learning and development (CPLD) plans and curriculum of prospective teacher educators (pre-service teachers) with the specific factors that are known to improve a teacher's TPACK."

Alhashem, F. (2021), Analyzing plans of localizing professional development of the Ministry of Education in Kuwait based on TPACK model for the rolling out competency-based curriculum. *Education Quarterly Reviews*, *4*(1), 113-121. https://doi.org/10.31219/osf.io/scrfw

Abstract: "The aim of this study was to investigate the localized training for teachers during the reform of the education system in Kuwait between 2015 and 2017. It focuses on analyzing the professional development plans that were delivered to teachers for four core subjects in elementary and middle public schools. A mixed-method approach was employed, using quantitative one-way ANOVA and in-depth interviews and school visits to collect and analyze data. The results revealed that stakeholders and education leaders lacked clarity of purpose with respect to planning for professional development and did not rely on a cohesive framework for training teachers, resulting in discrepancies among all training plans. The study concludes with recommendations for the adaptation of a national framework for professional development based on educational theory and teachers' needs."

Alrwaished, N., Alkandari, A., & Alhashem, F. (2017). Exploring in- and pre-service science and mathematics teachers' technology, pedagogy, and content knowledge (TPACK): What next? *Eurasia Journal of Mathematics, Science and Technology Education*, *13*(9), 6113-6131. https://doi.org/10.12973/eurasia.2017.01053a

Abstract: "The call to reform education systems is being heard in many countries around the world. The purpose of this study is to develop and apply a framework that captures some of the essential qualities of the knowledge required by teachers for effective pedagogical practice in a technology-enhanced educational environment using technology and pedagogy content knowledge (TPACK). A TPACK Short and Quick (TPACK-SQ) survey questionnaire was used to explore and assess 244 in- and pre-service science and mathematics teachers in Kuwait. The results of the survey showed that in-service teachers needed help with some aspects of TPACK. Therefore, a workshop was developed and 57 in-service teachers were enrolled and trained based on the TPACK-SQ model. The results of posttests for their knowledge were significantly positive as against pretests. The workshop thus provides a rich example of how to support the implementation of essential elements of the TPACK-SQ model."

Anat, K., Shirley, R., & Hanna, L-Z. (2020). Building a computerized dynamic representation as an instrument for mathematical explanation of division of fractions. *International

Journal of Mathematical Education in Science and Technology, *51*(2), 247–264. https://doi.org/10.1080/0020739X.2019.1648888

Abstract: "This study describes a teaching process that offers teachers and pupils ways of constructing the division operation through illustration based on defining the reference unit (divisor), the reference whole[1] and the dividend. We introduce a computerized dynamic environment, using an Excel spreadsheet, in which both teachers and pupils can independently construct the solution process in a manner that leads to meaningful learning. Nine pairs of teachers and pupils underwent an intervention process using Excel, comparing pupils' understanding of division of fractions before and after the learning process. Findings from the pupils indicate the Excel software enabled them to portray and construct the meaning of the division process while applying accurate mathematical terms. Specifically, they could thoroughly understand the meaning of a word problem, so as to explain another student's mistake. Furthermore, teachers' analyses of the pupils' work indicate that the use of this computerized dynamic environment helped the teachers develop mathematical knowledge, pedagogical knowledge and technological pedagogical knowledge."

Anjarani, S. (2020). Unpacking the TPACK framework in EFL context: A review of empirical studies from 2015 to 2019. *Jurnal Ide Bahasa*, *2*(2), 81-90. https://doi.org/10.37296/idebahasa.v2i2.42

Abstract: "Technological Pedagogical Content Knowledge (TPACK) has been implemented as a conceptual framework for the knowledge domains that teachers need to master to successfully teach using technology and it has attracted a lot of attention across the field of education. Nonetheless, the framework has been criticized for not being practically useful. TPACK studies were mostly conducted in Mathematics and Science. Meanwhile, research on integrating English as a foreign language (EFL) into TPACK has been lagging behind. To better understand the critics, an investigation of general characteristics of TPACK studies in EFL context is needed. This paper is a systematic literature review of 20 peer-reviewed journal articles concerning the use of TPACK in EFL context published from 2015 to 2019."

Arifin, Z., Nurtanto, M., Priatna, A., Kholifah, N., & Fawaid, M. (2020). Technology andragogy work content knowledge model as a new framework in vocational education: Revised technology pedagogy content knowledge model. *TEM Journal*, *9*(2), 786–791. https://www.temjournal.com/content/92/TEMJournalMay2020_786_791.html

Abstract: "Nowadays, the ICT is an important part of the 21st century and teacher learning and industry 4.0 challenges must involve technology in their teaching and learning. Previous research on the involvement of technology in the learning process is generally known as TPACK, Technology – Pedagogy – Content - Knowledge. However, the specific objectives of implementing vocational learning are specific to certain occupations. The purpose of this study is to analyse the teaching and learning needs of students in professional vocational education with the revised TPACK new model approach. The study of qualitative methods in the form of document analysis is used to construct a new theoretical conceptual framework. Important

findings offered in the concepts of teaching and learning of vocational students were adopted based on work, content, technology, and learning approaches which were conceptualized as TAWOCK. The work as a new domain shows the characteristics of student teaching and learning while the learning approach has shifted from the level of engagement - Pedagogy to the level of cultivation - Andragogy. The study explains that vocational education with the TAWOCK concept is an ideal model for developing depth."

Arya, P., Christ, T., & Wu, W. (2020). Patterns of technological pedagogical and content knowledge in preservice-teachers' literacy lesson planning. *Journal of Education and Learning*, *9*(5). https://doi.org/10.5539/jel.v9n5p1

Abstract: "This study explored the patterns of Technological Pedagogical and Content Knowledge (TPACK) in 45 preservice teachers' literacy lesson plans that integrated digital texts or tools. A priori coding and content analysis were used to identify preservice teachers' demonstrations of combinations of TPACK constructs. Findings indicated that preservice teachers demonstrated TPACK (41%) and combined Technological Content Knowledge and Pedagogical Content Knowledge most frequently (42%), Pedagogical Content Knowledge less frequently (13%), and other patterns rarely, combined Technological Content Knowledge and Technological Pedagogical Knowledge (1%), Technological Content Knowledge (1%), Technological Pedagogical Knowledge (0%) and combined Pedagogical Content Knowledge and Technological Pedagogical Knowledge (0%). This study cohered with previous research that found just under half of teachers demonstrated TPACK. However, it differed from previous studies that did not show patterns of Pedagogical Content Knowledge but Technological Pedagogical Knowledge, as our data showed Pedagogical Content Knowledge but not Technological Pedagogical Knowledge. Finally, it extended previous research by identifying patterns of literacy preservice teachers' demonstrations of TPACK in their elementary literacy lesson plans. It also demonstrated new ways of combining TPACK constructs (i.e., Technological Content Knowledge and Pedagogical Content Knowledge, Technological Content Knowledge and Technological Pedagogical Knowledge, and Pedagogical Content Knowledge and Technological Pedagogical Knowledge), which when used to code the data resulted in a more comprehensive definition of TPACK. Only 2% of the lesson plans did not demonstrate any of the combinations."

Aryani, O. D., Bharati, D. A. L., & Astuti, P. (2021). Teachers' practices in using educational mobile applications to teach English. *English Education Journal*, *11*(1), 37-55. https://doi.org/10.15294/eej.v11i1.40710

Abstract: "English language learning has shifted with the development of technology in education. Learning can also be done through easy access from a mobile phone. Educational mobile applications bridge the teaching learning processes effectively. This study aims to investigate the teachers' practices in using educational mobile applications to teach English in senior high school in Semarang. This study utilizes case study approach to achieve the objectives of the study. Questionnaire, interview, document analysis, and classroom

observation were applied to investigate the teachers' practices in using educational mobile applications in relation to multimedia learning theory and the Technological Pedagogical Content Knowledge (TPACK) theory. An evaluation rubric was used to find out the effectiveness of the educational mobile applications the participants used in teaching. Then a compatibility checklist was used to find out the compatibility of the educational mobile applications with the current curriculum, the 2013 curriculum. The findings revealed that the teachers were aware of multimedia learning when they chose to use certain educational mobile applications to teach English. They also possessed what the TPACK suggested. Therefore, they had the tools they needed to integrate technology into their classrooms. The study showed that from the five educational mobile applications the teachers used, Google Classroom was the most effective, whereas Goggle Drive was the least effective. The other three, 360 Video, YouTube, and Google Slides could, meanwhile, be considered effective apps. In case of compatibility of the educational mobile apps with the 2013 curriculum, it could be said that all of the educational mobile applications were compatible with the curriculum since they were applicable in classroom settings."

Aslam, R., Khan, N., Asad, M.M. and Ahmed, U. (2021). Impact of technological pedagogical content knowledge on teachers' digital proficiency at classroom in higher education institution of Pakistan. *Interactive Technology and Smart Education*. Advance online publication. https://doi.org/10.1108/ITSE-11-2020-0222

Abstract: "Purpose: This paper aims to address the relationship of teachers' technological pedagogical content knowledge (TPACK) and their technology proficiency according to the International Society for Technology in Education Standards for Teachers (ISTE-ST) in public and private universities of Karachi, Pakistan.

Design/methodology/approach: Quantitative approach with survey research design was used. In total, 520 teachers of public and private universities were selected on the basis of simple random sampling technique. Data was collected through questionnaire distribution.

Findings: Strong significant correlation was found between teacher' TPACK and teachers' technology proficiency, teachers' ability to engage in professional development and teachers' ability to promote digital citizenship and responsibilities in students.

Originality/value: TPACK and ISTE-ST are used for effective teaching. TPACK is used to measure teachers' ability to integrate technology in their teaching, while ISTE-ST is used to measure the proficiency technology integration. This study is unique as it discusses the relationship of TPACK and ISTE-ST framework in term of teachers' ability to promote digital citizenship and responsibilities in students and teachers' ability to engage themselves in professional development program."

Assadi, N., & Hibi, W. (2020). Developing pre-service teachers' mathematics TPACK through an integrated pedagogical course. *Creative Education*, *11*(10), 1890-1905. https://doi.org/10.4236/ce.2020.1110138

Abstract: "Lesson planning and presentation are regarded as an effective method that allows pre-service teachers to gain experience in the instructional processes and improve teaching skills. Lesson Portfolio and Presentations, not only is utilized as a method for increasing the quality of a teacher's education, but also used to research the Technological Pedagogical Content Knowledge(TPACK) framework. The purpose was to investigate changes in pre-service teachers' TPACK from their lesson portfolio and presentation practices conducted un-der the TPACK framework. The participants are 22 third-year pre-service teachers. An analysis was performed based on specific concepts from the projects, which had been developed to reveal the changes in pre-service teachers' TPACK components. Content analysis was used to analyze the observation forms, self-evaluations, videos and interviews. The study's findings indicate that pre-service teachers use GeoGebra tools to attain what they had specified in their instructional plans. When considered in terms of the TPACK components, pre-service teachers made noticeable progress."

Avidov-Ungar, O., Leshem, B., Margaliot, A., & Grobgeld, E. (2018). Faculty use of the active learning classroom: Barriers and facilitators. *Journal of Information Technology Education: Research*, *17*, 495-504. https://doi.org/10.28945/4142

Abstract: "Aim/Purpose: The study aimed to examine teacher educators' perceptions regarding their ability to implement innovative pedagogies following a year during which they used a newly equipped Active Learning Classroom (ALC), designed for teacher training.

Background: To this end, we asked how participants perceived the effective use of the ALC and how they were able to leverage the use of the ALC to implement innovative pedagogies.

Methodology: Using the grounded theory method, we conducted qualitative analysis of data collected from semi-structured in-depth personal interviews. The sample included 22 randomly-selected teacher educators in a single teacher-education college, who had used the ALC over the last year. Average teaching tenure was 22 years.

Contribution: As part of the transition to using innovative pedagogies in an ICT (Information Communication Technology) enhanced teaching environment, our proposed model can be used to map teachers' perceptions and proficiencies, so as to address the specific needs of each group.

Findings: Analysis revealed four pedagogic teaching patterns. Based on the TPACK (Technology, Pedagogy, and Content, Knowledge) model as a theoretical framework, we were able to relate these patterns to participants' strengths and weaknesses in technological and pedagogic knowledge and the ways in which they used the ALC. These patterns testify that there are different levels of use and integration of technology and pedagogy by teacher educators.

Recommendations for Practitioners: Enhancing teachers' knowledge, promoting innovative concepts and removing barriers for ICT usage require integrated technological-pedagogic guidance, which should be provided to the teachers by instructors with integrated TPK (Technology Pedagogy Knowledge).

Recommendations for Researchers: The ability to map technological and pedagogic strengths in accord with teaching patterns and styles provides an advantageous and applicable foundation that can be used by any future studies that wish to pursue this line of investigation.
Impact on Society: Formulating new strategies in teacher education would effectively make teacher educators the leading force driving the desired transformation, whereby teachers have the skills and knowledge to prepare students to become productive members of society in the 21st century.

Future Research: Future studies are encouraged to use our proposed model (which maps technological and pedagogic strengths in accord with teaching patterns) to examine additional questions, for example, what is the relationship between teaching style and teaching effectiveness and can it provide the impetus to attempt to shift teachers' attitudes and styles?"

Backfisch, I., Lachner, A., Hische, C., Loose, F. & Scheiter, K. (2020). Professional knowledge or motivation? Investigating the role of teachers' expertise on the quality of technology-enhanced lesson plans. *Learning and Instruction, 66.* https://doi.org/10.1016/j.learninstruc.2019.101300

Abstract: "In an expertise study with 94 mathematics teachers varying in their relative teacher expertise (i.e., student teachers, trainee teachers, in-service teachers), we examined effects of teachers' professional knowledge and motivational beliefs on their ability to integrate technology within a lesson plan scenario. Therefore, we assessed teachers' professional knowledge (i.e., content knowledge, pedagogical content knowledge, technological knowledge), and their motivational beliefs (i.e., self-efficacy, utility-value). Furthermore, teachers were asked to develop a lesson plan for introducing the Pythagorean theorem to secondary students. Lesson plans by advanced teachers (i.e., trainee teachers, in-service teachers) comprised higher levels of instructional quality and technology exploitation than the ones of novice teachers (i.e., pre-service teachers). The effect of expertise was mediated by teachers' perceived utility-value of educational technology, but not by their professional knowledge. These findings suggest that teachers' motivational beliefs play a crucial role for effectively applying technology in mathematics instruction."

Bagheri, M. (2020). Validation of Iranian EFL Teachers' Technological Pedagogical Content Knowledge (TPACK) Scale. *The Electronic Journal for English as a Second Language*, *24*(2). http://tesl-ej.org/pdf/ej94/a2.pdf

Abstract: "The present study reports the process of developing and validating a self-report questionnaire that can be employed to examine technological pedagogical content knowledge (TPACK) perceptions of Iranian EFL teachers. To conduct the study, a survey instrument

consisting of items adapted from two existing TPACK-based survey instruments was generated. The content validity of the items was evaluated by two ELT experts who were experienced in teaching English with technology. The resulting survey was then administered to a group of participants (N = 206), its construct validity was established using Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA), and its reliability was calculated using Cronbach's alpha method. The results of statistical analyses indicated that responding teachers could distinguish six out of seven constructs in the original TPACK framework. Moreover, items associated with the knowledge required for teaching with the Web and the Internet loaded on a separate factor. Therefore, a seven-factor solution comprising of 31 items was proposed, and it was concluded that the constructed survey instrument was a valid and reliable tool for measuring perceived level of technology integration literacy among Iranian English instructors. Implications for validating future TPACK surveys and planning ICT courses in Iran's EFL settings are discussed."

Baier, F., & Kunter, M. (2020). Construction and validation of a test to assess (pre-service) teachers' technological pedagogical knowledge (TPK). *Studies in Educational Evaluation*, *67*(100936). https://doi.org/10.1016/j.stueduc.2020.100936

Abstract: "As society becomes increasingly digital, teachers must be trained to integrate technology effectively into their classrooms. Teachers' technological pedagogical knowledge (TPK), as defined in the TPACK framework, is considered an important prerequisite for effectively integrating technology. The TPACK framework has received a great deal of attention, yet few knowledge tests have been developed that directly assess TPK. However, those tests are crucial for evaluating the effectiveness of teacher education courses on technology integration. We have developed a 17-item test that covers teacher knowledge about various digital technologies as employed in teaching. Experts rated the items to represent the construct adequately. Data obtained from 245 pre-service teachers supports the test's internal structure. Concerning convergent and discriminant validity, the pre-service teachers' test scores were not related to their self-reported TPK, but to their self-reported technological knowledge. The test was sensitive to changes in pre-service teachers' TPK through teacher education courses."

Başaran, B. (2020). Investigating science and mathematics teacher candidate's perceptions of TPACK-21 based on 21st century skills. *Elementary Education Online*, *19*(4), 2212-2226. https://doi.org/10.17051/ilkonline.2020.763851

Abstract: "Twenty-first century teachers are expected to have the ability to benefit from collaboration, problem solving, creative and innovative thinking, information and communication technology (ICT) applications. Teachers need to know various pedagogical approaches and appropriate ways to use ICT to support the development of twenty-first century skills of their students. The framework of technological pedagogical content knowledge (TPACK) provides a theoretical model for studying the way teachers use ICT in education. The purpose of this study is to reveal the relationships of the components that constitute the TPACK-21 scale. The data were collected from 254 teacher candidates at a state university in Turkey from the science and math departments in the academic year of

2017-2018. For this purpose, the relationships between the components/factors that constitute the TPACK-21 scale were examined with a model. Relational survey model was used in the research. In the research, the scale developed by Valtonen et al. (2017) determining prospective teachers' 21st century skills of TPACK-21 was used. The data obtained in the study were analyzed by structural equation modeling. The direct and positive effects of Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK21) and Pedagogical Content Knowledge (PCK21) from external variables consisting of binary knowledge fields of the research are seen on TPACK-21. These variables explain 74% of the change in TPACK-21. TCK is the variable that affects TPACK-21 the most. Another important result reached in this study is that teachers' content knowledge (CK) directly and positively affect TCK and PCK21 and this effect is greater than the effect of technological knowledge (TK) and pedagogical knowledge (PK21). When the results of this research are evaluated, a gradual model including CK and PCK21 can be proposed instead of a direct technology-based approach to professional development programs developed to increase 21st century competencies of teachers' TPACK-21s."

Bergeson, K. & Beschorner, B.(2020). Modeling and scaffolding the technology integration planning cycle for pre-service teachers: A case study. *International Journal of Education in Mathematics, Science and Technology (IJEMST)*, *8*(4), 330-341. https://www.ijemst.net/index.php/ijemst/article/viewFile/1031/230

Abstract: "This case study explored pre-service teachers"(PSTs) efforts to consider the integration of digital technology as they learned to use their developing TPACK to plan literacy instruction. PSTs were introduced to the Technology Integration Planning Cycle (TIPC; Hutchison & Woodward, 2014) to support their learning. They observed modeling of the TIPC in practice, participated in group work, and discussed meaningful technology integration. The findings suggest that PSTs: (a) used new knowledge of digital tools to plan instruction, (b) could align their pedagogy to their use of a digital tool, and (c) believed that integrating technology was important. Further, four of the PSTs were observed during their field experience. Each used digital tools to support literacy goals. However, based on reflections from the overall group of PSTs in their literacy methods course, PSTs also felt overwhelmed by the selection of a digital tool that would support a literacy goal, struggled to know how to overcome obstacles, and had a difficult time using technology in a way that enhanced their literacy goal. The current findings add to the existing literature on using the TIPC with PSTs by describing a process of providing PSTs with modeling, scaffolding, and opportunities for guided practice."

Bernardes, T. S., & de Andrade Neto, A. S. (2020). Technological pedagogical content knowledge (TPACK) in pre-service and in-service chemistry teacher training: A systematic literature review. *Revista Novas Tecnologias na Educação*, *18*(2), 611-620. https://doi.org/10.22456/1679-1916.110304

Abstract: "To guide the integration of Information and Communication Technologies (ICT) in the classroom, the theoretical model Technological Pedagogical Content Knowledge

(TPACK), proposed by Mishra and Koehler in 2006, reinforces the importance of connecting pedagogical, technological, and content knowledge of teachers. This research sought to investigate the literature on how the theoretical model TPACK is being used for the integration of technology in Chemistry teaching. This investigation was based on a Systematic Literature Review (SLR), reaching a sample of 23 articles published in scientific journals from 2006 to 2019. In general, the researches that composed this SLR uses the theoretical model TPACK in a more theoretical way and mostly in in-service teacher training. The lack of research in the Brazilian context signals the need for more work supported by this framework, which can lead to practices that are more aligned with the contemporary needs of Chemistry teacher training."

Budiwati, N., & Adirestuty, F. (2019). The effect of self-efficacy mediation to the influence between teacher experience and teacher training towards technological pedagogy and content knowledge. *The International Journal of Business Review (The Jobs Review), 2*(2),121-132. https://doi.org/10.17509/tjr.v2i2.22281

Abstract: "This research was inspired by the rapid development of information and communication technology. It obligates teachers to apply technology and information in learning for enriching their professionalism. This research aims to determine the significance of the effect on teacher experience, training, and self-efficacy on TPACK, as well as determining the significance of teacher experience and training on self-efficacy. The used method in this research was descriptive method with data collection techniques through distributing questionnaires to economics teachers. Path analysis technique is used to analyze the data. Based on the results of the analysis, it was found that teacher experience, training, and self-efficacy had a significant positive effect on TPACK. Teacher experience and training have a significant positive effect on self-efficacy. Yet, self-efficacy is not able to mediate the effect of teacher experience on TPACK, and the effect of training on TPACK."

Carpenter, J. P., Rosenberg, J. M., Dousay, T. A., Romero-Hall, E., Trust, T., Kessler, A., Phillips, M., Morrison, S. A., Fischer, C., & Krutka, D. G. (2020). What should teacher educators know about technology? Perspectives and self-assessment. *Teaching and Teacher Education*, *95*, 103124. https://doi.org/10.1016/j.tate.2020.103124

Abstract: "This article offers a first look at teacher educators' (*N* = 336) perceptions of their technology competencies based on the Teacher Educator Technology Competencies (TETCs; Foulger, Graziano, Schmidt-Crawford, & Slykhuis, 2017). The participants generally rated their competence levels highly in relation to the TETCs. Although many participants reported that the TETCs adequately reflected the competencies required of them, they suggested various additions and changes to the TETCs. This mixed-method study advances understanding of teacher educators' perceptions of the importance of various competences to their work and offers feedback from the field regarding which competencies might be missing from the TETCs."

Castéra, J., Marre, C. C., Yok, M. C. K., Sherab, K., Impedovo, M. A., Sarapuu, T., Pedregosa, A. D., Malik, S. K., & Armand, H. (2020). Self-reported TPACK of teacher educators across

six countries in Asia and Europe. *Education & Information Technologies*, *25*(4), 3003–3019. https://doi.org/10.1007/s10639-020-10106-6

Abstract: "The initial technological pedagogical and content knowledge (TPACK) model was theorised on seven clearly identified factors. However, many studies have failed to empirically identify these seven factors, and elements influencing TPACK level, such as national context, gender, and age, remain unclear. The study is focused on teacher educators' TPACK as one of the most important elements in schoolteacher training. The main goals were to test the validity of the initial TPACK seven-factor model in a cross-national analysis context and to identify factors influencing the TPACK perception. The sample was composed of 574 teacher educators coming from a total of eight schools of educational institutions from six countries. A 26-item questionnaire, based on a four-point Likert scale, investigated the seven factors of the TPACK model as independent scales. It was administered online and anonymously. A confirmatory factor analysis using the robust maximum likelihood method and Kruskal–Wallis chi-squared tests were performed. The study showed four major results: 1) a relative stability of the seven-factor model structure across countries; 2) the relative differences of university teachers' TPACK perceptions across six countries in Europe and Asia; 3) the dependence of age and TPACK factors; and 4) an independence of gender/academic level and TPACK."

Castro, R. D. R., & Santos, J. (2020). Technological pedagogical content knowledge (TPACK) in action: Application of learning in the classroom by pre-service teachers (PST). *Social Sciences & Humanities Open, 138*. http://dx.doi.org/10.2139/ssrn.3661054

Abstract: "Technological Pedagogical Content Knowledge (TPACK) is the effectiveness of the delivery of lesson with technology integration. The Pre-service Teachers (PST) were evaluated by their Cooperating Teachers and the result was supported by an interview made to the PSTs and their supervisors. Based on the result of the study, a more structured alternative approaches should be designed to help the teachers in the public schools implement 21 st century learning with integration of technology."

Cekerol, K., & Ozen, E. (2020). Evaluation of teachers' technological pedagogical content knowledge within the framework of educational information network and other variables. *Turkish Online Journal of Distance Education, 21*(5), 61-78. https://doi.org/10.17718/tojde.770914

Abstract: "The aim of this study is to examine the relationship between Technological Pedagogical Content Knowledge (TPACK) of teachers teaching at different levels of educational institutions and demographic information about them as well as their technology and Educational Information Network (EIN) use. The participants of the study were determined by using stratified sampling method from the teachers teaching in state-run primary schools, secondary schools and high schools in Eskisehir in Turkey. 364 teachers voluntarily participated in the study by filling out the data collection tool. The first part of the survey includes questions to collect demographic data about the participants as well as the ones related to their technology and EIN use. The second part involves TPACK scale developed by Horzum, Akgun

and Ozturk (2014). According to the results of the statistical analysis, the teachers find themselves competent in terms of TPACK factors and there are significant differences between TPACK factors and demographic information about the participants as well as their technology and EIN use. It is believed that increasing technology knowledge of teachers will also improve their pedagogy and content knowledge. Therefore, it is suggested that more studies should be conducted which combine technology, pedagogy and content knowledge."

Cetin-Dindar, A., Kadioğlu-Akbulut, C., Küçük, S., & Sesen, B. (2020). Development and validation of the ICT-TPACK-science scale. *Journal of Science Education and Technology*, *29*, 355-368. https://doi.org/10.1007/s10956-020-09821-z

Abstract: "This study was conducted to develop a valid and reliable ICT-TPACK-Science Scale based on the transformative model taking into account the recent improvements in educational technologies specific to science education. The participants of the study included 722 pre-service science teachers from 12 universities in Turkey. The data were collected first for the exploratory factor analysis (n1 = 390), and then for the confirmatory factor analysis (n2 = 332). The exploratory factor analysis revealed a five-dimensional construct. The ICT-TPACK-Science Scale consisted of 38 items and five factors, namely planning, designing, implementing, ethics, and proficiency. The confirmatory factor analysis provided a good fit, supporting the five-factor solution. Therefore, it can be concluded that the ICT-TPACK-Science Scale is a reliable and valid instrument to measure pre-service science teachers' TPACK. The prominent property of this scale is that the framework of the scale is based on the transformative approach, and it is also specific to pre-service science teachers."

Chai, C. S., Jong, M., & Yan, Z. (2020). Surveying Chinese teachers' technological pedagogical STEM knowledge: a pilot validation of STEM_TPACK survey. *International Journal of Mobile Learning and Organization, 14.* https://doi.org/10.1504/ijmlo.2020.10026335

Abstract: "As STEM education is increasingly drawing attention from different parts of the world, there is also an emerging call for STEM education to be synthesised with the TPACK framework for the purpose of teacher professional development. Unfortunately, teacher professional development for integrative STEM education anchored by engineering design has been lacking. This study attempts to integrate STEM and TPACK framework as a means to advance the state of affairs. In particular, a STEM TPACK survey was created and validated in this study. The exploratory factor analysis indicates that the four factors, i.e. the technological pedagogical science knowledge, technological pedagogical mathematics knowledge, technological pedagogical engineering knowledge and integrative STEM can be identified. The regression analysis indicates that the three TPACK factors can predict the teachers' integrative STEM efficacy. In addition, teachers who have experienced teaching STEM classes are generally more efficacious in their STEM TPACK knowledge. Overall, the study indicates that teachers' TPACK are associated with their efficacy in implementing STEM education. This implies that it is important to expound further teacher professional development efforts using the TPACK framework, and the inclusion of mobile apps could be important."

Chandra, V., & Lloyd, M. (2020). Lessons in persistence: Investigating the challenges faced by preservice teachers in teaching coding and computational thinking in an unfamiliar context. *Australian Journal of Teacher Education*, *45*(9). http://dx.doi.org/10.14221/ajte.2020v45n9.1

Abstract: "An ongoing problem for teacher education institutions is bridging the gap between theory and practice and offering authentic experiences to challenge preservice teachers' pedagogical decision-making. Preservice practicums simulate teaching and can, at best, offer controlled experiences in familiar settings. This restricts the opportunities for preservice teachers to develop confidence in their own pedagogical decision-making and to adapt curriculum to meet unknown or unforeseen conditions. This paper describes, through a small-scale qualitative case study, a teaching experience in an unfamiliar setting, the persistent actions taken to respond to a specific context and the impact this had on preservice teacher knowledge and self-efficacy. The study found that preservice teacher self-efficacy can be scaffolded in real-world contexts provided sufficient planning, peer support and mentoring is available."

Cheng, L., Antonenko, P. D., Ritzhaupt, A. D., Dawson, K., Miller, D., MacFadden, B. J., Grant, C., Sheppard, T. D., & Ziegler, M. (2020). Exploring the influence of teachers' beliefs and 3D printing integrated STEM instruction on students' STEM motivation. *Computers & Education, 158*. https://doi.org/10.1016/j.compedu.2020.103983

Abstract: "As an emerging technology in K-12 education, 3D printing has gained much attention from educators and researchers. However, meaningful 3D printing integration in K-12 curricula is still scarce, and little is known about how teachers' beliefs and the integration in science classrooms may influence student motivation. This study examined the influence of teachers' beliefs and 3D printing integration in science classrooms on students' science, technology, engineering, and mathematics (STEM) motivation, which is essential for students' academic experiences and future careers. Study sample included 26 teachers across 6 states in the U.S. and 1,501 students who engaged with STEM learning using 3D printing in the context of paleontology. Teachers' lesson plans were analyzed to examine 3D printing and STEM integration levels. Teachers' beliefs and students' STEM motivation were assessed with previously validated scales. Multilevel modeling analyses indicated that while teachers' beliefs and 3D printing integration levels were non-significant predictors, teachers' STEM integration levels positively predicted students' math motivation. Interaction effects were observed between student variables (student gender and pretest scores) and teacher variables (teacher beliefs and 3D printing integration). This study provides implications for both 3D printing integration practice and future research."

Cheung, Y. L. & Jang, H. (2020). Understanding writing teachers' technological pedagogical content knowledge: A study with five in-service teachers. *Indonesian Journal of Applied Linguistics*, *10*(2), 551-561. https://doi.org/10.17509/ijal.v10i2.28607

Abstract: "The growing emphasis on emerging technologies in education has required in-service teachers to develop more technological knowledge. However, little is known about the application of technological pedagogical content knowledge (TPACK) on subject matter knowledge in language teaching. This qualitative study examined five writing teachers' implementation of instructional objectives, instructional strategies, and technologies to teach writing as well as their assessment of learning using the TPACK-Writing perspective. Lesson observations were conducted for each teacher. Adopting a case study design, the observation transcripts were analyzed with a focus on the teachers' execution of the instructional objectives, instructional strategies, and technologies to teach writing as well as their assessment of learning. The results showed that the complex nature of writing pedagogy with TPACK-Writing as a construct was mediated by cultural factors such as an examination-oriented system and teacher-centered pedagogy. The results also suggested that the application of TPACK-Writing should involve a student-centered approach rather than a teacher-centered approach, which implies the need for teachers to acquire a high level of knowledge of learners and the instructional context to promote effective pedagogy."

Ching, G.S., & Roberts, A. (2020). Evaluating the pedagogy of technology integrated teaching and learning: An overview. *International Journal of Research Studies in Education*, *9*(6), 37-50. https://doi.org/10.5861/ijrse.2020.5800

Abstract: "The advent of COVID-19 has critically changed how we perceived the process of teaching and learning today. To cope with these changes, the classroom of today is without a doubt full of technologies that makes teaching and learning more effective and exciting. Come to think of it, is it exciting? YES! Is it effective? ...well, not so sure. To shed light on this, the current presentation shall focus on the understanding how practitioners are able to evaluate technology integrated education. First, a brief summary of the evolution of educational information technologies and its current types and usages shall be provided. Second, an introduction of the ADDIE and the Technological Pedagogical Content Knowledge (TPACK) model and together with its overarching influences shall be explained. Lastly, a discussion on the theoretical background and sample research studies on the various forms (and derivatives) of the Technology Acceptance Model (TAM) shall be given. In essence, no matter how far information technology advances the pedagogical design created by teachers is still more important than the technology itself. It is hoped that the current presentation can provide various exemplars for practitioners to follow and study during this crucial time of teaching and learning within a pandemic."

Dalal, M., Archambault, L., & Shelton, C. (2021). Fostering the growth of TPACK among international teachers of developing nations through a cultural exchange program. *Australasian Journal of Educational Technology*, *37*(1), 43–56. https://doi.org/10.14742/ajet.5964

Abstract: "This study investigated the impact of a semester-long technology course as part of a higher education cultural exchange program for secondary school teachers of developing

nations. We integrated quantitative data from surveys that evaluated participants' technological pedagogical content knowledge (TPACK), with qualitative evidence from participants' technology-based lesson designs. Analysis across the 16 participants indicated that the course was effective in improving teachers' TPACK. Teachers reported increases in all TPACK domains, with the largest growth in technological content knowledge and TPACK. However, qualitative analysis suggested greater presence of technological pedagogical knowledge. Teachers learned to consider affordances of technology in accordance with content or pedagogy, but their ability was limited due to resource constraints or students' readiness. Results suggest that international exchange programs are a valuable way to support teachers of developing nations in building educational technology capacity at their home schools."

Dee-Chan, R. (2020). "Introducing the technological pedagogical content knowledge (TPACK) framework to the University of Santo Tomas Faculty of Medicine and Surgery. *Journal of Medicine, University of Santo Tomas*, *4*(1), 474-476. https://doi.org/10.35460/2546-1621.2019-0054

Abstract: "Technological developments affect both teaching and learning. The inclusion of educational technologies provides a tremendous boost and motivation in knowledge acquisition of the millennial, tech-savvy students much like our University of Santo Tomas Faculty of Medicine and Surgery (USTFMS) medical students. Technological Pedagogical Content Knowledge or TPACK is the buzzword for this novel approach. Its goal is to create an effective learning environment for students and more importantly, TPACK is essential in the preparation of the outcomes-based curriculum of the doctor of medicine (MD) program."

Dolgopolovas, V., Dagiené, V., & Jeviskova, T. (2020). Methodological guidelines for the design and integration of software learning objectives for scientific programming education. *Scientific Programming*, *2020*(807515). https://doi.org/10.1155/2020/6807515

Abstract: "The motivation for the research is the need to develop an integrated and holistic approach to fostering students' scientific inquiry based on scientific programming education by conducting computational experiments and simulations. At the same time, the implementation of the learner-centred approaches to scientific programming education and the related development of science, technology, engineering, and mathematics (STEM) learner-centred educational environment are of primary importance for K-16 education. The key interest is how to design and integrate learning resources which include software learning objects for making simulations. The research investigates educational aspects of the technological, pedagogical, and content knowledge (TPACK) framework applied to scientific computing and scientific programming educational domain and provides methodological guidelines and design principles of practical implementation of educational resources. These include design principles for the development of the model-based scientific inquiry-centred learning resources, generic design templates for designing educational aspects of scientific programming education, generic use case models for learning resources for scientific programming education, and supportive methodological considerations."

Ebil, S. H. (2020). The use of E-portfolio for self-reflection to promote learning: A case of TVET students. *Education and Information Technologies.* Advance online publication. https://dx.doi.org/10.1007/s10639-020-10248-7

Abstract: "The power of reflection is highly acknowledged to promote learning and develop expertise, yet reflective skills are rarely explicitly taught in schools. As a result, encouraging reflection among learners is often difficult to accomplish, especially in the Technical and Vocational Education and Training (TVET) setting. By employing the Technological Pedagogical Content Knowledge (TPACK) construct, this research investigated the use of structured reflection through digital learning portfolios (e-portfolio) and explores its relation to students' learning. Using mixed methods design, this study examined a group of students from one of the TVET institutions in Brunei over an eight-week period as they practiced reflection through e-portfolio designed to guide the students to reflect upon their own learning. The students' e-portfolio notes were converted to Students' Reflective Scores (SRS) as a measure of level of reflection. The data gathered revealed that although student performance can have a moderate effect on students' level of reflection, building structured opportunities to reflect and integrate learning can develop students' ability to reflect better. The quality of students' reflection had significantly increased throughout the study period as more students exhibited higher-order thinking in their e-portfolio. Meanwhile, the key themes emerging from the semi-structured interview data revealed that while students see reflection in detached ways, the intervention had provided the opportunity for students to enhance both their cognitive and metacognitive skills. The students' responses also implied that operational feasibility of e-portfolio for Brunei TVET might depend on teachers' input, students' motivation, type of e-portfolio software chosen, and connectivity setting."

Eutsler, L. (2021). TPACK's pedagogy and the gradual release of responsibility model coalesce: Integrating technology into literacy teacher preparation. *Journal of Research on Technology in Education.* Advance online publication. https://doi.org/10.1080/15391523.2020.1858463

Abstract: "This study explored how the pedagogical knowledge construct of TPACK and a scaffolded use of the gradual release of responsibility framework helped preservice teachers design literacy instruction with the iPad. This qualitative study used an interpretivist approach and case study design to closely examine each participant's(n¼38) experience to use the iPad to plan instruction. Data were triangulated with observation logs, individual surveys, and lesson artifacts. Thematic analysis revealed three themes: Teacher in Control pedagogical approach raised preservice teachers' concerns about instructional planning; Teacher as Facilitator pedagogical approach led to increased user confidence and exploration; Problem-based Learning pedagogical approach led to in-depth design of comprehensive lessons for individualized student populations. Other teacher educators can adopt this approach when introducing students to technology."

Falloon, G. (2020). From digital literacy to digital competence: the teacher digital competency (TDC) framework. *Educational Technology Research & Development*. Advance online publication. https://doi.org/10.1007/s11423-020-09767-4

Abstract: "Over the years, a variety of frameworks, models and literacies have been developed to guide teacher educators in their efforts to build digital capabilities in their students, that will support them to use new and emerging technologies in their future classrooms. Generally, these focus on advancing students' skills in using 'educational' applications and digitally-sourced information, or understanding effective blends of pedagogical, content and technological knowledge seen as supporting the integration of digital resources into teaching, to enhance subject learning outcomes. Within teacher education institutions courses developing these capabilities are commonly delivered as standalone entities, or there is an assumption that they will be generated by technology's integration in other disciplines or through mandated assessment. However, significant research exists suggesting the current narrow focus on subject-related technical and information skills does not prepare students adequately with the breadth of knowledge and capabilities needed in today's classrooms, and beyond. This article presents a conceptual framework introducing an expanded view of teacher digital competence (TDC). It moves beyond prevailing technical and literacies conceptualisations, arguing for more holistic and broader-based understandings that recognise the increasingly complex knowledge and skills young people need to function ethically, safely and productively in diverse, digitally-mediated environments. The implications of the framework are discussed, with specific reference to its interdisciplinary nature and the requirement of all faculty to engage purposefully and deliberately in delivering its objectives. Practical suggestions on how the framework might be used by faculty, are presented."

Ferranti, C., & De Rossi, M. (2020). The use of video narration to develop soft skills in initial teacher training. *Italian Journal of Educational Technology*, *28*(2), 168-182. https://doi.org/10.17471/2499-4324/1162

Abstract: "The narrative dimension allows us to understand reality and to organize knowledge in a hermeneutical and open way. It is also able to generate reflective learning and to stimulate skills that are not necessarily subject related. When narration turns into video narration, video production and artefact building processes can promote the development of soft skills, to be improved during the academic path and put into practice in future professional actions. This article presents the main results of an empirical study of a blended/hybrid digital video-narrative laboratory proposed to 132 university students doing undergraduate initial teacher training, extrapolated from a wider mix-method research study conducted at the university level. The study currently has the limitations of focusing on a single teaching area, but the encouraging results could be a stimulus to expand research on the use of video across the entire teacher training curriculum."

Forkosh-Baruch, A., Phillips, M. & Smits, A. (2021). Reconsidering teachers' pedagogical reasoning and decision making for technology integration as an agenda for policy, practice and research. *Educational Technology Research & Development*. Advance online publication. https://doi.org/10.1007/s11423-021-09966-7

Abstract: "This article focuses on preservice and in-service teachers' pedagogical reasoning, decision making and action concerning technology integration for learning. We examine this topic in light of three contemporary barriers in policy, practice and research, namely: the lack of an integrative model that considers how teachers come to shape their reasoning and decisions on technology integration, the lack of practical-authentic experience for preservice teachers for technological pedagogical reasoning and decision-making, and the influence of software that automates classroom decisions and may reshape teacher reasoning. We offer three resulting opportunities: the introduction of an integrated epistemic and developmental model that explains how teachers' pedagogical reasoning and action (PR&A) for technology integration are shaped , teaching approximations of core practices for technology integration, and promoting PR&A and decision-making for simple adaptive Digital Formative Assessment Tools as an overall agenda to enhance policy, practice and research relating to teachers pedagogical reasoning, decision making and action in technology rich contexts. We conclude in proposing implications for policy, practice and research."

Foster, A., & Shah, M. (2020). Principles for advancing game-based learning in teacher education. *Journal of Digital Learning in Teacher Education*, *36*(2), 84–95. https://doi.org/10.1080/21532974.2019.1695553

Abstract: "In this analytical paper, we argue for the centrality of teachers in game-based learning (GBL) interventions. We examine the following research question, *"What principles emerge from teacher education in game-based learning research conducted from 2007–2018?".* In doing so, we examine evidence generated over 10+ years deductively and inductively using thematic analysis, to identify six principles that can guide research and practice in teacher education for GBL. These principles include: (a) Teachers play an active role in GBL environments; (b) Games are a form of curriculum; (c) GBL is a way of facilitating learning; (d) Games are not contextually or pedagogically neutral; (e) Teachers' knowledge of GBL evolves over time; and (f) Teachers' professional identities impact GBL practice. We conclude with pathways to engage the teacher education community in a critical assessment of how we can scaffold teachers to identify-study-incorporate games for learning."

Galanti, T. M., Baker, C. K., Morrow-Leong, K. and Kraft, T. (2020). Enriching TPACK in mathematics education: Using digital interactive notebooks in synchronous online learning environments. *Interactive Technology and Smart Education*. Advance online publication. https://doi.org/10.1108/ITSE-08-2020-0175

Abstract: "Purpose: In spring 2020, educators throughout the world abruptly shifted to emergency remote teaching in response to an emerging pandemic. The instructors of a graduate-level synchronous online geometry and measurement course for practicing school

teachers redesigned their summative assessments. Their goals were to reduce outside-of-class work and to model the integration of content, pedagogy and technology. This paper aims to describe the development of a digital interactive notebook (dINB) assignment using online presentation software, dynamic geometry tools and mathematical learning trajectories. Broader implications for dINBs as assessments in effective distance learning are presented.

Design/methodology/approach: The qualitative analysis in this study consists of a sequence of first-cycle coding of mid-semester surveys and second-cycle thematic categorizations of mid-semester surveys and end-of-course reflections. Descriptive categorization counts along with select quotations from open-ended participant responses provided a window on evolving participant experiences with the dINB across the course.

Findings: Modifications to the dINB design based on teacher mid-semester feedback created a flexible assessment tool aligned with the technological pedagogical content knowledge (TPACK) framework. The teachers also constructed their own visions for adapting the dINB for student-centered instructional technology integration in their own virtual classrooms.

Originality/value: The development of the dINB enriched the TPACK understandings of the instructors in this study. It also positioned teachers to facilitate innovative synchronous and blended learning in their own school communities. Further analysis of dINB artifacts in future studies will test the hypothesis that practicing teachers' experiences as learners increased their TPACK knowledge."

Garbin, M. C., Oliveira, E., Pirillo, N. R., & Telles, S. (2020). Pedagogical practices based on areas of knowledge: Reflections on the technology use. *New Trends and Issues Proceedings on Humanities and Social Sciences. 7*(1), 134-141. https://doi.org/10.18844/prosoc.v%vi%i.4877

Abstract: "The appropriation of technologies in education must consider the specificities of each knowledge field and propose the demand for its pedagogical use. In distance learning (DL), which relies on the use of technologies, the reflection on the use of this resource becomes fundamental. Processes, methodologies and materials are usually standardised due to time and production costs. It is necessary to identify an intermediate point in this standardisation that takes into account the specificities of the knowledge fields. This study aims to discuss the pedagogical practices in DL considered appropriate to the knowledge fields, in the appropriate combination of contents, technologies and pedagogical practices. The methodology adopted is qualitative, using survey as a data collection tool. In conclusion, this article indicates that there are, actually, more effective teaching practices for each knowledge field. There are still recommendations in order to study deeply the real learning in each teaching practice."

Gozukucuk, M. & Gunbas, N. (2020). Preservice teachers' design of technology–based reading texts to improve their TPACK. *Journal of Education*. Advance online publication. https://doi.org/10.1177/0022057420966763

Abstract: "The purpose of this study is to contribute to preservice teachers' technological pedagogical content knowledge (TPACK). For this purpose, preservice teachers (n = 8) learned visual programming language, designed technology-based reading activities, and observed students completing these activities. A case study approach was employed, and preservice teachers' views about the process were taken. Results showed that the preservice teachers' beliefs in technology integration in education positively changed. They believe they learned teaching reading skills to elementary school students in an untraditional approach. They believe the whole process contributed to their personal and professional development. Implications are made based on the TPACK framework."

Guggemos, J., Sailer, M., & Seufert, S. (2020). Technology-related knowledge, skills, and attitudes of pre- and in-service teachers: The current situation and emerging trends. *Computers in Human Behavior.* Advance online publication. https://doi.org/10.1016/j.chb.2020.106552

Abstract: "This is the introductory article for the special issue "Technology-related knowledge, skills, and attitudes of pre- and in-service teachers". It (1) specifies the concept of technology-related knowledge, skills, and attitudes (KSA) of teachers, (2) presents how these KSA are currently assessed, and (3) outlines ways of fostering them among pre- and in-service teachers. The eight articles in the special issue are structured accordingly, and we demonstrate how they contribute to knowledge in these three areas. Moreover, we show how the afterword to the special issue widens the perspective on technology integration by taking into account systems and cultures of practice. Due to their quantitative empirical nature, the eight articles investigate technology at the current state of the art. However, the potential of artificial intelligence has not yet been fully exploited in education. We provide an outlook on potential developments and their implications on teachers' technology-related KSA. To this end, we introduce the concept of augmentation strategies."

Guggemos, J., & Seufert, S. (2021). Teaching with and teaching about technology: Evidence for professional development of in-service teachers. *Computers in Human Behavior*, *115*(2021), 1066613. https://doi.org/10.1016/j.chb.2020.106613

Abstract: "The digital transformation has implications for how and what to teach. For the purpose of professional development, the paper at hand presents a conceptual framework for predicting the use of technology as a means and as a content of instruction. It is informed by the TPACK framework and the 'will, skill, tool' model. The predictors are Technological Knowledge (TK), Technological Pedagogical Knowledge (TPK), Technological Pedagogical Content Knowledge (TPACK), Technological Collaboration Knowledge (TCoK), and Attitudes. These constructs are measured by newly developed self-assessment instruments. Structural equation modeling using a sample of 212 in-service teachers from commercial schools in German-speaking Switzerland lend support to the soundness of the measurement instrument and the conceptual framework. Overall, 36% of the variance of the use of technology as a means and 45% of the variance for the use as the content of instruction can be explained. Mediation and multigroup analyses, a finite mixture segmentation, comparisons of competing

models, and factor score regression yielded evidence for the robustness of the conceptual framework."

Hall, J.A., Lei, J. & Wang, Q. The first principles of instruction: an examination of their impact on preservice teachers' TPACK. *Educational Technology Research & Development*, *68*, 3115–3142. https://doi.org/10.1007/s11423-020-09866-2

Abstract: "The flipped approach has been widely adopted in higher education, yet its theoretical framework and use in teacher preparation courses have been limited. To address these gaps, this study examined the impact of the First Principles of Instruction when applied to designing face-to-face and flipped technology integration courses. Participants were 32 preservice teachers enrolled during the 2017 spring and fall semesters. Employing a 3-way mixed factorial research design, we measured participants' technological, pedagogical, content knowledge (TPACK) outcomes in each group and compared the outcomes between the face-to-face and flipped groups. In both groups, preservice teachers' self-perceptions and application of TPACK statistically significantly increased. The magnitude of the TPACK application results (F2F $p < .001$, $d = 1.17$; Flipped a $p < .001$, $d = 1.97$) strongly demonstrates the First Principles' potential to frame effective course design. Further analyses revealed no statistically significant differences between groups' TPACK outcomes. These non-significant differences suggest the First Principles of Instruction may be equally effective for designing flipped and face-to-face courses. We conclude the article by discussing implications for course design and detailing considerations for future research on flipped approaches."

Hämäläinen, T., Ifinedo, E., & Rikala, J. (2020). Factors affecting Nigerian teacher educators' technology integration: Considering characteristics, knowledge constructs, ICT practices and beliefs. *Computers in Education, 146*. https://doi.org/10.1016/j.compedu.2019.103760

Abstract: "To provide a diverse comprehension of teachers' *TPACK* (Technological, Pedagogical, and Content Knowledge) and how TPACK is reflected in practice, this study examined teacher educators' (TEs') conceptions of technology integration. Specifically, the main objective of the study was to investigate the factors influencing Nigerian teacher educators' technology integration using a self-completion survey administered to Nigerian teacher educators from three schools in the southern region of Nigeria. We utilized the partial least squares structural equation modeling (PLS-SEM) approach for the data analysis. Two frameworks—TPACK and Second Information Technology in Education Study (*SITES*)— guided the scale development. The results indicated that three constructs (perceived technological knowledge, teachers' knowledge [excluding technology] and perceived knowledge for integrating technology) directly influenced the TEs' technology integration, while two others (information and communication technology [ICT] pedagogical practices and perceived effect on students) did not. Among the teachers' characteristics, teaching experience, and class size were found statistically associated with their technology integration. The results of this study are beneficial for developing professional training to help teachers integrate technology specifically by developing their ICT

pedagogical practices. Through such training, teachers could be enlightened on how to align their perceived effect of teaching with technology."

Hauck, M., Müller-Hartmann, A., Rienties, B. & Rogaten, J. (2020). Approaches to researching digital-pedagogical competence development in VE-based teacher education. *Journal of Virtual Exchange*, *3*(SI) pp. 5–35. http://doi.org/10.21827/jve.3.36082

Abstract: "For the past two decades, Virtual Exchange (VE) has enjoyed increasing popularity in university education, including initial (language) teacher education programmes (O'Dowd, 2018). Collaborating online with colleagues and students from different cultural backgrounds and educational systems has allowed trainees to experience and reflect on issues related to technology and pedagogy in authentic linguistic and intercultural contexts. In 2017/2018, the Evaluating and Upscaling Telecollaborative Teacher Education (EVALUATE) project – an Erasmus+ funded European Policy Experimentation (EPE) – collected and analysed data from VEs across the curriculum involving over 1,000 participants at Initial Teacher Education (ITE) institutions in Europe and beyond.

Here, we specifically focus on the impact of VE on their digital-pedagogical competence development. Following a mixed method design we used the Technological PedagogicalContent Knowledge (TPACK) work of Mishra and Koehler (2006) and Schmidt et al. (2009) in a pre-post-test manner. These were complemented by qualitative content analysis of prompted diary entries at key stages during the exchanges to collect further evidence of existing and emerging digital-pedagogical skills among the trainees. Based on one case study of a German-Polish EVALUATE exchange we will exemplify the aforementioned research methods and associated challenges. We will illustrate the urgent need for initial and in-service teacher education that combines technology and pedagogy and argue for VE as an ideal context to this effect. Finally, we will demonstrate how the chosen research approach has contributed to providing the kind of evidence required by education administrators and policy makers for a systematic integration of VE into teacher education programmes."

Hawk, N. A., & Nelson, M. J. (2020). The impact of field experiences on prospective preservice teachers' technology integration beliefs and intentions. *Teaching and Teaching Education, 89*. https://doi.org/10.1016/j.tate.2019.103006

Abstract: "This study investigated how field experiences impacted the technology integration beliefs and intentions of prospective preservice teachers. Using structural equation modeling (SEM), a three-way interaction between the type, frequency, and quality of field technology observations predicted changes in beliefs and intentions. Beliefs about the utility of technology directly predicted intentions to use technology and intentions to use Meaningful Learning approaches to technology integration. Additionally, beliefs about technology's importance in education indirectly predicted both variables. Positive impacts of field experiences on beliefs and intentions only existed when prospective preservice teachers saw technology used frequently by skilled teachers using Meaningful Learning approaches."

Hayati, E., Nursyifa, A., & Rahmadi, I. F. (2020).TPACK capability preservice teachers civic education in the era of industrial revolution 4.0. *Jurnal Pendidikan Indonesia*, *9*(1), 15-29. https://doi.org/10.23887/jpi-undiksha.v9i1.17982

Abstract: "This research aims to determine the ability of the Technological Pedagogical Content Knowledge (TPACK) of preservice teachers in Civic Education Pamulang University. The method used in this research is a quantitative method with survey approach. The research subjects were 63 students. The results showed that the ability of TPACK has a very important role in improving the ability of preservice teachers in the 4.0 industrial revolution. Besides the analysis results showed the ability of TPACK Preservice teachers Civic education on group A superior to the group B. Therefore, TPACK's capabilities need to be upgraded and supported by various parties to create an education that can produce future qualified teachers."

Heinrich, E., Henderson, M., Redmond, P., & Saubern, R. (2020). TPACK - Time to reboot? *Australasian Journal of Educational Technology*, *36*(3), 1-9. https://doi.org/10.14742/ajet.6378

Abstract: "In this paper we explore and challenge the trajectory of research scholarship in the area of Technological, Pedagogical and Content Knowledge (TPACK). In doing so we adopt the position, as elaborated in Harris et al.'s (2017) editorial, that TPACK research is in need of addressing two key questions: What do teachers need to know in order to integrate technology effectively in the classroom and how can they best develop that knowledge? In order to explore this concern we undertook a review of research using the TPACK framework published in the *Australasian Journal of Educational Technology* over the last five years. The resulting 22 papers in which the TPACK framework was used substantially as a theoretical or methodological base for the research was analysed in regards to how TPACK scholarship is developing in relation to the research directions set out in the Harris et al.'s (2017) special edition editorial. The review concludes that much of the research identified focused on exploring, critiquing and validating the structure of the TPACK diagram and the seven components it describes. However, we argue that this focus has distracted researchers from addressing the key goals of TPACK and advancing understanding of effective teaching with technology. We conclude that there is a need for a fundamental shift in the trajectory of TPACK research, that is, to pay greater attention to understanding the knowledge that teachers need to use technology effectively for teaching and learning."

Hicks, D., Lisanti, M., & van Hover, S. (2020). Shifting the gaze: (Mis)using actor-network-theory to examine preservice teachers' uses of digital technologies. *Contemporary Issues in Technology and Teacher Education*, *20*(4), 730-742. https://www.learntechlib.org/primary/p/217448/

Abstract: "This paper responds to the recent call for technoskeptical or critical studies of educational technology in the classroom. The authors intentionally push against more established theoretical frameworks used in the field of teaching with technology by testing

Latour's Sociology of Translation or Actor-Network-Theory (ANT) to shift the gaze away from solely knowledge-based or dispositional accounts of teachers' use of digital technologies within the social studies. When used alongside qualitative methods, ANT sensibilities open up an analytical middle ground between sociocultural and sociomaterial perspectives to help illuminate new perspectives regarding how certain forms of digital technologies are favored over other technologies by social studies preservice teachers within the contexts of their internship classrooms over time and space."

Hidayah, B., Na'im, M., & Puji, R. P. N. (2020). Technological content knowledge of history teachers in Jember. In M. Hum Sumardi (Ed.), *IOP Conference Series: Earth and Environmental Science*, *485*(2020), 012132. https://iopscience.iop.org/article/10.1088/1755-1315/485/1/012132

Abstract: "Based on the Regulation of the Minister of Education and Culture of the Republic of Indonesia Number 22 of 2016 concerning Basic and Secondary Education Process Standards that the learning process can be carried out by utilizing information and communication technology to improve the efficiency and effectiveness of learning. In accordance with the era of industrial revolution and increasingly sophisticated technological developments, requires that educators can integrate technology with the content of learning materials. The results of previous studies indicate that most teachers in Jember Regency are considered not creative, only 30 percent of teachers are creative and literate in information technology and as many as 70 percent of teachers are not creative, they still teach with conventional techniques, without using information technology. The purpose of this study is to analyze the technological content knowledge of historical educators in Jember Regency. This type of research is descriptive research. Data collection methods in this study are questionnaire. The questionnaire technique carried out by researchers was by distributing questionnaires or questionnaires to educators using a self assessment, with the help of Statistical Package for the Social Si (SPSS) version 22 program. Based on the results of descriptive statistics the level of technological content knowledge history educators in Jember Regency scored (M = 3.29, SD = 0, 417), 60.6% of Technological content knowledge history educators in Kabupaten Jember are at a good level. And as many as 27.3% are at a sufficient level. Then at a low level of 12.1%, while at a very low level and very good at 0%. So, it can be concluded that the level of technological historical knowledge content in Jember Regency is at a good level."

Hidayah, F. F., Imaduddin, M., Praptaningrum, D. N. W., & Ristanti, D. A. (2020). Cogenerative dialogue of cross-generation educators to improve chemistry teaching quality through technology. *Journal for the Education of Gifted Youth*, *8*(1), 465-487. https://doi.org/10.17478 / jegys.654941

Abstract: "This research showed the efforts of educators in improving the quality of the chemistry classroom atmosphere through technology. Cogenerative dialogue involved a dialogue between a small number of students, teachers and researchers. This discussion featured an ethnographic case study from the co-teaching and cogenerative dialogue involving junior lecturers, certified chemistry teachers, preservice chemistry teachers, and students in the

chemistry learning about chemical bonding, chemical elements, and laboratory introduction. This dialogue is guided by questions related to Technological Pedagogical Content Knowledge (TPACK). The SWOT analysis was used to provide an overview experienced by educators as well as TPACKing process. The use of a simple application that is a music player, video and camera can be easily used to make the class more enjoyable. Students enjoy a more comfortable classroom atmosphere with song rhythms, funny videos, and selfie activities. Constraints in mastering concepts macroscopically, sub-microscopically, and symbolically are completed by utilizing virtual/augmented reality and virtual laboratory. Cogenerative dialogue can inspire educators to try and learn the technology for teaching chemistry."

Hobley, J. (2021). Cultivating learners who "think like vocational professionals:" Signature pedagogies, technology and vocational learning. *Research in Post-Compulsory Education*, *26*(1), 38-58. https://doi.org/10.1080/13596748.2021.1873407

Abstract: "The author is Teaching and Learning Manager at the college with rsponsibility for observation of all teaching staff and their professional development. This research looks at differing concepts of pedagogy through an investigation of observation data and an analysis of 'blended learning sessions' at a college that is at the forefront of using technology as a tool for learning. Located in South Central England this is a relatively small vocational college with two sites in Hampshire. The observation data collected was analysed using the concepts of Pedagogical Content Knowledge (PCK), Technological Pedagogical Content Knowledge (TPCK), Signature Pedagogies and expansive vocational education to see how these concepts applied to practice. The conclusion shows that whilst there were differences in the pedagogical content approach, the concept of signature pedagogies was strong across all the curriculum areas looked at. It also highlights the possibility of further international research into post compulsory online learning using this college as an example of good practice. Finally, it observes that the college has the capacity in terms of a dedicated team of technologists to really improve the TPCK of the teachers further, together with a comprehensive digital strategy that encompasses a coherent and planned curriculum using 'joined up' schemes of work. In this way the PCK and the TPCK of teachers will be strengthened."

Hsu, C., Liang, J., & Tsai, M. (2020). Probing the structural relationships between teachers' beliefs about game-based teaching and their perceptions of technological pedagogical and content knowledge of games. *Technology, Pedagogy and Education*, *29*(3), 297-309. https://doi.org/10.1080/1475939X.2020.1752296

Abstract: "The aim of this study was, first, to validate the instruments of Technological Pedagogical Content Knowledge-Games (TPACK-Games) and the Game-based-learning Teaching Belief Scale (GTBS). Second, a series of analyses were conducted to examine differences and relationships among the factors of the TPACK-Games and GTBS, in terms of different school levels. A total of 384 junior high school and elementary school teachers were recruited to complete the surveys. The study found that the TPACK-Games and GTBS surveys were valid and reliable instruments. Further, in comparison with teachers in junior high school, elementary school teachers tended to have higher self-efficacy in game pedagogical knowledge (GPK) and

game pedagogical content knowledge (GPCK). They also demonstrated stronger beliefs, confidence and motivation to use games in their classes. Teachers' GPK was the most influential factor in predicting their GPCK, and GPCK further positively predicted their beliefs, confidence and motivation in using games in class."

Hsu, Y-Y., & Lin, C-H. (2020). Evaluating the effectiveness of a preservice teacher technology training module incorporating SQD strategies. *International Journal of Educational Technology in Higher Education*, *17*(1), 1–17. https://doi.org/10.1186/s41239-020-00205-2

Abstract: "Preparation to use information and communication technology (ICT) is an important component of preservice language teachers' training, and various existing teacher training models propose a range of strategies for increasing their technology knowledge and technology adoption rates. However, the relative effectiveness of these strategies remains unclear. Based on Tondeur et al.'s (2012) Synthesis of Qualitative Data model, which delineates the six main teacher preparation strategies (i.e., role modeling, reflection, instructional design, collaboration, authentic experience, and continuous feedback), the present study designed a 4 week training module for preservice language teachers and examined how these training strategies affected 63 participants' perceived technology knowledge and attitudes toward technology adoption. Among the six training strategies, reflection and instructional design had the highest positive impacts on these preservice teachers' self-reported knowledge about and attitudes towards using ICT. As well as revealing the relative impacts of each training strategy, the results indicate that our designed training module has considerable potential for application to teacher training in other subjects."

Huang, L., & Lajoie, S. P. (2021). Process analysis of teachers' self-regulated learning patterns in technological pedagogical content knowledge development. *Computers & Education*, *166*(104169). https://doi.org/10.1016/j.compedu.2021.104169

Abstract: "Self-regulated learning (SRL) has a predictable and instrumental effect on learning complicated knowledge. This study investigates the role of SRL in acquiring technological pedagogical content knowledge (TPACK), an important aspect of teachers' effective technology use. The present study identified several regulatory procedural patterns used by teachers in the context of their TPACK achievements. A computer-based context, nBrowser, was used to facilitate teachers lesson planning around technology usage. Teachers log file data were analyzed using process mining approaches. Findings indicate that high TPACK performers are more likely to perform self-regulative activities (e.g., monitoring) in developing TPACK compared to the low performers. Higher TPACK performers are more goal-oriented, demonstrate more monitoring and are more iterative in using all SRL processes in contrast to low performers who only partially regulate their problem solving. Such findings support previous research. This study adopts a novel approach for understanding the relations between SRL and TPACK. It offers opportunities to examine how teachers enact SRL as they move from the beginning to later stages of designing lessons and provides insights to researchers who study SRL in TPACK domains. Furthermore, the findings can assist educational designers in

developing interventions for promoting TPACK development by concentrating on teachers' SRL abilities."

Huang, L., Li, S., Poitras, E. G., & Lajoie, S. P. (2021). Latent profiles of self-regulated learning and their impacts on teachers' technology integration. *British Journal of Educational Technology*, *52*(2), 695–713. https://doi.org/10.1111/bjet.13050

Abstract: "Past research shows that both teachers' technological pedagogical content knowledge (TPACK) and their engagement in metacognitive activities are essential to technology integration in the classroom. However, the interplay between teachers' TPACK ability and their metacognitive skills is still underexplored, especially in the context of developing technology-infused lesson plans. This study examined how the interrelations among metacognitive activities and TPACK constructs affected preservice teachers' technology integration in instructional design. Sixty-four preservice teachers designed a lesson with nBrowser, a computer-based learning environment (CBLE) that helps teachers incorporate technology into instruction by promoting self-regulated learning (SRL). Drawing on the lesson plans, we extracted six types of metacognitive processes preservice teachers exhibited while solving the task and generated two distinct SRL profiles according to the identified latent profile of metacognitive patterns. The competent self-regulated learners demonstrated more efforts in metacognitive monitoring activities than the less competent self-regulated learners in regulating their task solving processes. When comparing TPACK comprehension and design performance between the two profiles, the competent self-regulated learners outperformed the less competent self-regulated learners on comprehension and design outcomes. This study provides deep insights into teachers' self-regulation in CBLEs and emphasizes the pivotal role of metacognition and SRL in teachers' TPACK development."

Huang, M., & Lin, H. (2020). Improving strategies for information-based educational and teaching abilities of newly appointed college teachers using the TPACK hierarchical model. *International Journal of Emerging Technologies in Learning, 15*(14), 220-235. https://doi.org/10.3991/ijet.v15i14.15307

Abstract: "The improvement of strategies for information-based educational and teaching abilities of newly appointed teachers should be substantially investigated urgently based on the policy level of various countries or the reality of colleges and universities. However, from the perspective of the Technological Pedagogical Content Knowledge (TPACK) hierarchy, there are only a few studies on the strategies to improve the information-based educational and teaching abilities of newly appointed teachers. Therefore, this study analyzed the relationships between the three cores and four composite elements, designed the ability improvement strategy corresponding to each element, designed a hierarchical improving strategy which corresponds to 20 training contents, and used quasi-experimental research methods to apply the strategy to the 2019 newly recruited teacher training system of Guangdong University of Finance and Economics. Through the implementation of the training strategy for one semester and effect evaluation, combined with the comparative analysis of the training evaluation data of newly

appointed teachers who did not implement this strategy in 2018, it shows that the implementation of the strategy can significantly improve the information-based educational and teaching ability of newly appointed teachers, with good results."

Hughes, J. E., Cheah, Y. H., Shi, Y., & Hsiao, K-H. (2020). Preservice and inservice teachers' pedagogical reasoning underlying their most-valued technology-supported instructional activities. *Journal of Computer-Assisted Learning*, *36*(4), 549–568. https://doi.org/10.1111/jcal.12425

Abstract: "We examined teachers' pedagogical reasoning for and the technological knowledge underlying their most-valued technology-supported activities for teaching and learning. Data from 140 preservice and 100 inservice teachers included open-ended, narrative responses to survey questions. Qualitative research methods guided analysis of the data that identified (a) the technology-supported activities and (b) the technical tools, target users, types of uses, rationales for use, and the TPACK underlying each activity. Preservice teachers described mostly teacher-focused and fewer student-focused techno-activities, and their reasoning for use focused on the technology's presentational and engagement effects. A majority of inservice teachers' techno-activities were student-focused, and their reasoning highlighted the technology's support for knowledge acquisition of higher-order cognitive skills and collaborative learning. The knowledge underlying all teachers' techno-activities was predominantly technological pedagogical knowledge (TPK), but inservice teachers also evidenced technological content knowledge (TCK). These results may reveal differences in the teachers' respective learning experiences in teacher education and professional development or reflect a professional maturation process in that it takes teachers time in the field as professionals to broaden their techno-activity repertoires to prioritize student-focus. Sharing the reasoning patterns in this study with teachers may assist them in developing deeper justifications for their technological work in the classroom. Lay Description: What is already known about this topic: The instructional use of technology in PK-12 education is predominantly teacher-focused and transmissive in nature. Teachers' perceived technological pedagogical content knowledge may not aptly reflect their behavioural intentions or smoothly translate into enacted, aligned actions in the classroom. Little is known about teachers' pedagogical reasoning underlying their choices of instructional technology use and its relationship to technological pedagogical content knowledge. What this paper adds: Pre-service teachers described mostly teacher-focused techno-activities, and in-service teachers described more student-focused techno-activities. Pre-service and in-service teachers used different pedagogical reasoning for the same categories of technology-supported activities; thus they valued different technological features. Pre-service teachers applied less content-specific knowledge in their pedagogical reasoning as compared with in-service teachers, but both groups relied predominantly on technological pedagogical knowledge. Implications for practice and/or policy: Pre-service teachers' prominent use of and value for presentational technologies may indicate that modelling student- and/or content-focused techno-activities is needed within teacher preparation. Cultivating and sharing teachers' pedagogical reasoning for technology-integrated lessons may increase teachers' awareness and support deeper justifications within their technological decision-making."

Ifinedo, E., & Kankaanranta, M. (2021). Understanding the influence of context in technology integration from teacher educators' perspectives. *Technology, Pedagogy and Education*. Advance online publication. https://doi.org/10.1080/1475939X.2020.1867231

Abstract: "The perspective of teachers is important for advancing the use of technol-ogy in classrooms. A considerable number of research studies have explained context in ways that have narrowed the understanding of its impact on successful technology integration. This study employs the Technological Pedagogical and Content Knowledge (TPACK) model as a lens in understanding factors influencing teachers' integration of tech-nology in classrooms. Data were collected using focused interviews of 19 teacher educators of three colleges of education from the southern part of Nigeria. The results reveal that among the level contexts, the meso level presented the most challenges to teachers' efforts at integrating Information Communication Technology (ICT) in their classrooms. In addi-tion, the benefits of technology integration were expressed more in terms of the significance, practical use and the opportunities that ICT offers."

Jaramillo Cherrez, N., & Jin, Y. (2020). Cultivating instructor's reflection: Leveraging partnerships and team efforts. *College Teaching*, *68*(2), 62–70. https://doi.org/10.1080/87567555.2020.1723474

Abstract: "This case study documented the critical reflective practice of an instructor in a higher education context related to teaching and learning approaches. In particular, the reflections unveiled ways of seeing teaching and learning, learning through sharing experiences, developing technological pedagogical content knowledge (TPACK), and nurturing professional growth. Cultivating this reflective practice was possible through guided mentoring and collaboration with an instructional design team. Implications for cultivating reflective practice are discussed in light of enhancing the understanding of the complexities that teaching and learning encompass in higher education. Recommendations for cultivating critical reflection through mentoring and collaborating are presented."

Jin, Y., & Harp, C. (2020). Examining preservice teachers' TPACK attitudes, self-efficacy, and perceptions of teamwork in a stand-alone educational technology course using flipped classroom or flipped team-based learning pedagogies. *Journal of Digital Learning in Teacher Education*, *36*(3), 166–184. https://doi.org/10.1080/21532974.2020.1752335

Abstract: "The study's purpose was to investigate whether two different pedagogical strategies, flipped classroom and flipped team-based learning (FTBL), had different impacts on preservice teachers' TPACK, attitudes, self-efficacy, and perceptions of teamwork. Several survey instruments were sent to 32 preservice teachers who were Middle Grades Education majors at the beginning and end of the spring 2019 semester. Descriptive analyses, paired-samples *t*-tests, independent sample *t*-tests, and Pearson's correlation tests were run. The overall results showed that preservice teachers who enrolled in the FTBL section reported higher scores in most constructs. However, most comparisons had no statistically significant differences. The

results may help teacher educators to rethink the pedagogical strategies used in the stand-alone educational technology course and provide alternatives to the traditional teaching approach."

Jita, T., & Akintunde, M. A. O. (2021). Pre-service teachers' competence to teach science through ICTs: A case study of Lesotho. *The International Journal of Science, Mathematics and Technology Learning*, *28*(1), 27-40. https://doi.org/10.18848/2327-7971/CGP/v28i01/27-40

Abstract: "The study explored pre-service science teachers' perceived competencies for integrating information and communication technologies (ICTs) in their teaching during the field experience of Work-Integrated Learning (WIL). Two national tertiary institutions were purposively selected, and sixty-four final year pre-service science teachers completed questionnaires based on the technological pedagogical and content knowledge (TPACK) model. Data were analyzed quantitatively with the use of the Statistical Package for Social Science (SPSS) software. The respondents' mean scores in all seven TPACK domains were above the average of three. This implies that pre-service science teachers in Lesotho are competent in using ICTs to teach during WIL experience. However, the non-technological domains of TPACK received higher mean scores than the technological domains. It is recommended that more support mechanisms be put in place to maximize pre-service teachers' competencies in the technological domains. This article presents successful examples of ICT application during WIL by pre-service teachers and draws lessons for what needs to be done to promote the use of ICTs for teaching, especially in the context of a developing country."

Joubert, J., Callaghan, R., & Engelbrecht, J. (2020). Lesson study in a blended approach to support isolated teachers in teaching with technology. *ZDM-Mathematics Education, 52*, 907–925. https://doi.org/10.1007/s11858-020-01161-x

Abstract: "Lesson study (LS) is a form of professional development, with a strong foundation in mathematics education, based on teachers collaborating to design lessons. This collaboration, however, can be challenging for isolated teachers. In 2017, a course was presented at the university to train 52 teachers from all over South Africa as well as Botswana in the use of technology in teaching. These teachers represented all subject fields, including mathematics. The purpose of this course was to develop teachers' knowledge and skills in the use and integration of mobile technology in their teaching. The course was presented in a blended mode. Participants attended a 3-day face-to-face session, followed by 2-months online. The blended learning course had teachers working in subject specific groups in a LS format to plan, present and perfect lessons that can be taught using the technology available to them. In this study we investigate how LS can be adapted into a blended format to support isolated teachers who cannot meet face-to-face on a regular basis. We identified eleven aspects playing an important role in this process, namely technology; group; learning management system; online facilitation; technological pedagogical content knowledge (TPACK); (mobile) learning strategies; a lesson planning form; backward design; time; photos, videos and reports; and reflection questions. The eleven aspects that emerged, lead to the development of a framework

consisting of three dimensions of LS namely Collaboration, Instructional Development and the Iterative Improvement Process, supported by the identified aspects."

Juhji, J., & Nuangchalerm, P. (2020). Interaction between scientific attitudes and science process skills toward technological pedagogical content knowledge. *Journal for the Education of Gifted Young Scientists, 8*(1), 1-16. https://doi.org/10.17478/jegys.600979

Abstract: "The purpose of this research aims to study the interaction between scientific attitudes and science process skills toward technological pedagogical content knowledge. A survey research with an ex post facto design is employed. Data collection is carried out by direct observation, learning outcomes documents, questionnaire sheets which covered by science process skills, and scientific attitudes questionnaires. Seventy-eight students were taken randomly. The research instruments consisted of 14 items about basic science process skills, 18 items about integrated science process skills, and 28 items about scientific attitudes. Data analysis used descriptive statistics, regression analysis, and multiple correlations. The results showed that 1) positive interactions between basic science process skills in TPCK, 2) negative interaction between integrated science process skills in TPCK, 3) positive interactions between scientific attitudes towards TPCK, and 4) the presence of joint interactions -the same between science process skills and scientific attitudes toward TPCK. Further discussion needs to be carried out why this happens to help students understand scientific attitudes, scientific process skills, and TPCK as well."

Jumar, C. A. (2020). Technological pedagogical content knowledge among teacher educators working in colleges of education. *Alochana Chakra Journal*, *9*(5), 1340-1354. http://www.alochanachakra.in/gallery/167-acj-may-1612.pdf

Abstract: "The teaching landscape is rapidly changing, the technological rise of the 21stcenturyand widespread integration of those technologies into our society, combined with access to the internet has integrally changed teaching in just a few years. Educational technology implies a behavioural science approach to teaching and learning in that it makes use of pertinent scientific and technological methods and concepts developed in psychology, sociology, communications, linguistics and other related fields. It also attempts to incorporate the management principles of cost effectiveness and the efficient deployment and use of available resources in men and materials. Educational technology as a concept does not necessarily imply the use of machines and other items of hardware. Experience has shown that more often than not they involve such media, equipment and resources. The purpose of the present study was to find out whether there was any significant difference between teacher educators with regard to gender, subject taught and age in their TPACK and its dimensions and also to find out there was any significant influence of teacher educators teaching experience in their TPACK and its dimensions. The population of the present study consisted of teacher educators from colleges of education in Tiruchirappalli District of Tamil Nadu, India. The investigator adopted survey method of research to study the relationship between the variables and used stratified random sampling technique for collecting the required data. The sample for the present study consisted of

136 teacher educators. TPACK questionnaire were used for collecting the required data from the population. The major findings revealed that there was no significant influence of teacher educators teaching experience in their TPACK and its dimensions."

Jung, J., Ding, A. E., Lu, Y. H., Ottenbreit-Leftwich, A., & Glazewski, K. (2020). Is digital inequality a part of preservice teachers' reasoning about technology integration decisions? *American Behavioral Scientist, 64*(7), 994-1011. https://doi.org/10.1177/0002764220919141

Abstract: "Teachers' ability to design meaningful uses of technology for all learners in any classrooms has a potential to narrow digital gaps among K-12 students. However, we know little about whether teachers are prepared to consider these issues when making technology integration decisions. This study explored preservice teachers' knowledge use and their considerations about teaching practices related to digital inequality while reasoning about technology integration decisions. We analyzed interviews with and documents of a group of preservice teachers (N = 14) who completed a technology integration task in a technology integration course. Findings showed that although they used multiple domains of teacher knowledge throughout their reasoning processes, they paid limited attention to sociocultural aspects of teaching that demonstrated the ability to care about digital inequality issues. Implications are discussed in terms of ways to better prepare preservice teachers to deal with digital inequalities."

Kaaki, W. (2020). Adjunct online faculty and online student grades. *Distance Learning Journal*, *17*(1), 35-43.

Abstract: "Current research indicates that online student grades have dropped at for-profit online institutions, where adjunct online faculty made up for 80-90% of online faculty. Evidence of low online student grades in an era of increased use of adjunct online faculty exists. A quantitative nonexperimental study examined the relationship between adjunct online faculty working at a private for-profit online institution and online student grades. A total of 81 out of 148 faculty members participated. Results indicated technological, pedagogical, and content knowledge of adjunct online instructors did not predict online student grades; however, other variables are discussed in this article that may contribute to low online student grades."

Kale, U., & Akcaoglu, M. (2020). Problem solving and teaching how to solve problems in technology-rich contexts. *Peabody Journal of Education*, *95*(2), 127–138. https://doi.org/10.1080/0161956X.2020.1745612

Abstract: "Problem solving is perhaps the key characteristic that makes us human. Given the kinds of problems that we face in a competitive economy and society, the new generation of learners is ever more required to have problem-solving abilities. By drawing from the literature on technological pedagogical content knowledge, design thinking, general and specific methods of problem solving, and role of technologies for solving problems, this article highlights the importance of problem solving for future teachers and discusses strategies that can help them

become good problem solvers and understand the requirements of teaching their students problem solving in technology-rich contexts. This article consists of two main parts. Part 1 focuses on strategies required to help preservice teachers to be better problem solvers, and Part 2 summarizes approaches to introduce preservice teachers to the methods of teaching problem solving. The strategies reviewed provide a tangible guidance for teacher education programs regarding how to promote future teachers' problem-solving skills."

Kale, U., Roy, A., & Yuan, J. (2020). To design or to integrate? Instructional design versus technology integration in developing learning interventions. *Educational Technology Research and Development*, *68*(2020), 2473–2504. https://doi.org/10.1007/s11423-020-09771-8

Abstract: "Instructional Design Knowledge (IDK) can inform technology integration decisions and Technology Pedagogy and Content Knowledge (TPACK) can help instructional design processes. As a means to understand how teachers may draw from their TPACK and IDK as they design instructions and develop technology-enhanced learning activities, we examined the final projects of two groups of teachers enrolled in graduate-level instructional design and technology courses. By using both content and social network analysis methods, we identified the IDK and TPACK components exemplified in teachers' projects. While the content analysis revealed differences between the two groups, some findings were common across the courses such as teachers minimally connecting technology to their content areas, exhibiting limited knowledge on learning needs, and having difficulties in engaging in design thinking processes. Furthermore, the social network analysis identified various communities of the knowledge components, highlighting when teachers tended to use their IDK and TPACK as they planned technology-enhanced learning activities and were engaged in instructional design respectively."

Kapici, H. O., & Akcay, H. (2020). Improving student teachers' TPACK self-efficacy through lesson planning practice in the virtual platform. *Educational Studies*. Advance online publication. https://doi.org/10.1080/03055698.2020.1835610

Abstract: "How teachers use technology efficiently in their classes is an important issue because learning environments are also affected by rapid developments in instructional technology. In the current study, we investigated how designing an inquiry-based technology-enhanced lesson plan on the virtual platform influences the TPACK (Technological Pedagogical Content Knowledge) self-efficacy of pre-service teachers and also how they integrated educational technology into their lesson plans. A total of 38 undergraduate students at a teacher education programme participated in the study. Data were gathered by the self-efficacy scale and the lesson plans developed by the pre-service teachers. The findings revealed a significant increase in the TPACK self-efficacy of the pre-service teachers after they designed an inquiry-based technology-enhanced lesson plan on the virtual platform. Besides, lesson plan analysis showed that pre-service teachers generally followed the phases of inquiry-based learning and integrated online scaffolding tools and virtual laboratories into their plans at a moderate level."

Kimm, C., Kim, J., Baek, E-O, & Chen, P. (2020). Pre-service teachers' confidence in their ISTE technology-competency. *Journal of Digital Learning in Teacher Education*, *36*(2), 96–110. https://doi.org/10.1080/21532974.2020.1716896

Abstract: "As technology is an integral part of modern teaching and learning processes, teacher-candidates need to fully achieve a new set of technology competencies through ongoing and timely supports provided by teacher preparation institutions, state offices of education and school districts. This study measured the current technology-competency levels of 242 special and general education teacher-candidates in teacher preparation programs through a self-assessment survey that was developed based on the ISTE Educator Standards. The results show that teacher-candidates perceive that they have not yet reached a proficient level of technology-competency according to ISTE standards. Special education teacher-candidates with team-teaching experience reported a significantly higher level of technology-competency than any other groups. This paper provides insightful recommendations to teacher preparation institutes as to how they can reform their credential program curricula to support teacher-candidates in acquiring the technology competencies they need in the field of education."

Khoza, S. B., & Biyela, A. T. (2019). Decolonising technological pedagogical content knowledge of first year mathematics students. *Education and Information Technologies, 25,* 2665-2679. https://doi.org/10.1007/s10639-019-10084-4

Abstract: "Decolonising students' knowledge of technology, pedagogy, and mathematics content is important because it helps students understand their learning needs. Decolonisation is a process of critiquing and renewing the curriculum. Learning needs are circumstances that demand individuals' actions in order to address professional, personal, and/or social needs. The purpose of this article is to explore and decolonise students' knowledge of technology, pedagogy, and content in the learning of first year Bachelor of Education mathematics. Ten students learned a mathematics module at a South African university and were purposively selected to participate in this study. Semi-structured interviews, observation, and reflective activities/questionnaires, framed by critical action research, were used for data generation. The students' knowledge revealed that the technological pedagogical content knowledge (TPACK) was useful when used as the learning framework, which generated curriculum concepts for the module to support the student knowledge of technology, pedagogy, and content. The concepts were learning needs, content, goals, activities, time, environment, community, assessment, and GeoGebra resources. GeoGebra was the main learning resource that helped the students to integrate other resources into the module. The study concluded that, although the technological and content knowledge dominated the learning in other cases of the module, the pedagogical knowledge which was a result of their self-reflection to understand their identities, drove the module all the time. This study, consequently, recommends that students should use their knowledge of technology, pedagogy, and content as taxonomies of learning, in order to address mathematics, individual, and societal needs through the integration of technology."

Koh, J. L. H. (2020). Three approaches for supporting faculty technological pedagogical content knowledge (TPACK) creation through instructional consultation. *British Journal of Educational Technology,* 51(6), 2529-2543. https://doi.org/10.1111/bjet.12930

Abstract: "Despite the widespread availability of network and technology infrastructure at higher education institutions, the pedagogical innovation envisioned from technology-enhanced learning is still not prevalent. Faculty need to develop expertise for designing and implementing technology-enhanced learning strategies that is termed as technological pedagogical content knowledge (TPACK). This study uses action research to examine how one-to-one instructional consultation for technology-enhanced learning functions as an avenue for supporting faculty's TPACK creation. Through content analysis of the consulting notes from 18 consultation sessions, the study found that faculty can be supported to create TPACK through the consultation approaches of technology modelling, pedagogical realignment and deepening practice. These three approaches can be used during instructional consultation for faculty with varying objectives and experiences with technology-enhanced learning. The implications for faculty professional development in technology-enhanced learning are discussed."

Kong, S-C., Lai, M., & Sun, D. (2020). Teacher development in computational thinking: Design and learning outcomes of programming concepts, practices and pedagogy. *Computers & Education*, *151*, 103872. https://doi.org/10.1016/j.compedu.2020.103872

Abstract: "The implementation of effective professional development courses for K-12 teachers on computational thinking (CT) in relation to programming remains a challenge. There is a lack of high-quality empirical research on teacher development in CT in relation to programming. This study addressed that situation by providing empirical evidence of the design and evaluation of such a teacher development program in primary schools. Seventy-six in-service teachers participated in a program comprising two 39-h courses. One course focused on the fundamental subject knowledge of programming for CT development together with pedagogy. The other focused on the development of advanced knowledge while providing opportunities to practice teaching in the classroom and to reflect on the practice. The results indicate that the participants developed a better understanding of CT concepts and practices and improved in three of the four content knowledge related dimensions of technological pedagogical content knowledge (TPACK) across the two courses. The three dimensions were content knowledge of programming for CT development, technological content knowledge of the use of block-based programming environments for programming for CT development, and use of the environment to teach programming for CT development with the appropriate pedagogy in context. Analysis of the participants' self-reported reflections suggested that the two courses and the teaching experience acquired during the prolonged second course were the two main sources of improvement. This study demonstrates the importance of providing an effective teacher development program with a focus on CT concepts and practices. The program offers teachers a sustained period in which to practice in the classroom and reflect on their teaching while developing their capacity to implement CT in relation to programming. • A teacher development program for CT in relation to programming was designed and evaluated. • Teachers' CT concepts and practices improved consistently in the program. • In-service teachers

attended the program and improved in all content-knowledge related TPACK dimensions. • A sustained period of active participation in programming activities was essential. • Opportunities to reflect on pedagogy in practicing CT in programming activities was important."

Koyuncuoglu, O.(2021). An investigation of graduate students' technological pedagogical and content knowledge (TPACK). *International Journal of Education in Mathematics, Science, and Technology (IJEMST)*, *9*(2), 299-313. https://doi.org/10.46328/ijemst.1446

Abstract: "This study aimed to investigate and compare the perception of TPACK competence of graduate students studying at the institutes of Natural Sciences, Social Sciences and Educational Sciences based on the variables of gender, graduate program level and field. The participants of the research consist of 186 graduate students studying at the institutes of Karatay, Necmettin Erbakan and Selçuk University. TPACK Competence Scale was used to collect research data. The results of the research showed that graduate students' technological knowledge and TPACK competence were moderate. It was also found that male graduate students' technological knowledge and technological content knowledge were high, whereas female participants had a high-level perception of pedagogical knowledge. In addition, perceptions of TPACK competence varied based on the field and level of graduate education."

Ku, C.-J., Loh, W.-L. L., Lin, K.-Y., & Williams, P. J. (2020). Development of an instrument for exploring preservice technology teachers' maker-based technological pedagogical content knowledge. *British Journal of Educational Technology*, *52*(2), 552-568. https://doi.org/10.1111/bjet.13039

Abstract: "With the development of the maker movement, more and more teachers are applying a broad range of technological tools in their pedagogy, instead of only information technology. This study details the development and validation of the Teachers Maker-based TPACK Survey Instrument (TMTSI), a revised model designed to measure technology teachers' maker-based technological pedagogical content knowledge (TPACK) in utilizing maker-based tools to support their teaching. We recruited 165 preservice secondary technology teachers in Taiwan for this study and confirmatory factor analysis was applied to validate the instrument. Our findings suggest that TMTSI provided a valid and highly reliable research-based instrument that also serves as a professional development model to help scaffold the development of K-12 technology teachers. This paper details the theoretical foundations of TMTSI, reports on its reliability and validity, and discusses the application and implications of TMTSI for teacher education and professional development."

Kurban, K. (2020). Characterizing middle grade mathematics teachers' technological pedagogical content knowledge (TPACK) using a robust data set. *The Texas Forum of Teacher Education*, *10*, 3-16. https://txate.org/resources/Documents/Kurban%202020.pdf

Abstract: "Teachers' combined knowledge of contents, technologies, and the pedagogical methods has become a focus of understanding and evaluating teachers' quality. Much of the research uses rubrics to assess technological pedagogical and content knowledge (TPACK) but are limited in that the data sources are oftentimes only lesson plans. The purpose of this study was to characterize mathematics teachers' TPACK using a robust data set that includes the lesson planning process (written lesson plan), implementation of the lesson as represented through video, and teacher reflection about the lesson. Fifteen middle grade mathematics teachers' Technology Lesson Cycles data (the robust data) were assessed and analyzed using a pretested rubric which is the first part of the study. Findings from the study illustrate that the in-service mathematics teachers' pedagogical knowledge (PK) and the knowledge components that contain PK are relatively weaker than other components. Among all seven TPACK components, the technological pedagogical knowledge (TPK) was the weakest knowledge component. This work brought forward a deeper understanding of how TPACK translates to practice. Recommendations were provided for teacher education programs and for future studies. "

Kurniawan, B. R., Masjkur, K., Purwaningsih, E., Sari, A. M., Yuliati, L., & Zahiri, M. A. (2020). Improving the problem-solving skills through the development of teaching materials with STEM-PjBL (science, technology, engineering, and mathematics-project based learning) model integrated with TPACK (technological pedagogical content knowledge). *Journal of Physics Conference Series*, *1481*, 1-7. https://doi.org/10.1088/1742-6596/1481/1/012133

Abstract: "The biggest challenge for teachers in this industrial revolution 4.0 is to create a learning design that improves students' problem-solving skills. Many students face difficulties in applying physics concepts in life since their problem-solving skills are relatively low. Therefore, valid, practical, and effective teaching materials with the STEM-PjBL model integrated with TPACK can be used as the breakthrough. This learning tool is packaged in five steps with various learning experiences, and the students are directly involved in using ICT, making a video, PPT, and using Moodle. This research and development used 4D design with four stages, i.e., 1) define, 2) design, 3) develop, and 4) disseminate. In the define and design stages, need analysis and development of draft teaching materials were carried out. Development is an expert validation stage, and its results were declared as very valid. Dissemination is a limited trial phase with one group pretest-posttest design to see its practicality and effectiveness. The results of dissemination were stated to be very practical, showing that the learning plan can be well implemented. The students' problem-solving skills increased after they attended learning by using the developed device. Other findings showed that students were more excited, happy, and comfortable in learning physics."

Kusuma, I. P. I. (2021). TPACK-related programs for pre-service English teachers: An in-depth analysis on efforts and issues of ICT integration. *Jurnal Cakrawala Pendidikan*, *40*(1), 183–195. https://doi.org/10.21831/cp.v40i1.28820

Abstract: "As the advances of technology bring some changes in education, technology affects teacher training institutions, especially on the integration of Information and Communication Technology (ICT) that supports Technological Pedagogical Content Knowledge (TPACK) programs for English pre-service teachers. Regarding the ICT integration in TPACK-related programs, this study was then conducted to investigate the efforts done by the universities and lecturers and issues faced by the lecturers during the integration processes. This case study was conducted in Indonesia. The participants were 79 lecturers from 25 teacher education institutions implementing TPACK-related programs. This study employed an explanatory sequential mixed-method design in which the data were collected by means of questionnaires consisting of 23 items and interviews containing 5 questions. The results revealed that in general, almost all universities had provided ICT resources, accessibilities, ICT competence development programs, and policies on ICT implementation. On the one hand, for the sake of ICT integration in TPACK related programs, the lecturers provided students with accessibilities, knowledge of ICT, and classroom regulations. However, there are problems faced by those lecturers to integrate ICT in TPACK-related programs. Thus, some possible implications of ICT integration are presented in this study."

Lavidas, K., Katsidima, M.-A., Theodoratou, S., Komis, V., & Nikolopoulou, K.. (2021). Preschool teachers' perceptions about TPACK in Greek educational context. *Journal of Computers in Education*. Advance online publication. https://doi.org/10.1007/s40692-021-00184-x

Abstract: "Technological Pedagogical Content Knowledge (TPACK) is considered a promising theoretical framework for understanding the knowledge teachers require for effective ICT integration. This study investigates the perceptions of 147 Greek in-service preschool teachers about their knowledge and skills regarding ICT inte-gration in their educational practices. In this context, a scale of 28 items was used to record teachers' perceptions according to the seven domains of the TPACK model. The validity and the reliability of the scale used were established. Moreover, the findings revealed that preschool teachers have satisfactory perceived self-efficacy for the integration of ICT in all seven domains of TPACK. Teachers' age, teaching experience, and educational level seem to explain the perceived self-efficacy for ICT integration. The ICT teacher training program about ICT integration in classroom practices is indicated as the basic factor for integrating ICT in teaching. Implications for preschool teacher professional development are discussed."

Long, T., Zhao, G., Li, X., Zhao, R., Xie, K., & Duan, Y. (2020). Exploring Chinese in-service primary teachers' technological pedagogical content knowledge (TPACK) for the use of thinking tools. *Asia Pacific Journal of Education*. Advance online publication. https://doi.org/10.1080/02188791.2020.1812514

Abstract: "This study aimed at developing a scale, Technological Pedagogical Content Knowledge-Thinking Tools (TPACK-TT), and exploring Chinese in-service primary teachers' TPACK concerning the use of thinking tools. By revising a previous Chinese TPACK survey and validating with exploratory factor analysis, a six-component (i.e., TK-TT, PK, CK, TPK-TT, PCK, and TPCK-TT) scale with 31 items was developed. Research data gathered from 204 primary

teachers from a variety of schools revealed that teachers with different educational backgrounds and various overall teaching experiences did not show statistical differences in most components of the TPACK-TT. However, male teachers demonstrated significantly higher TK-TT and TPK-TT than female teachers, teachers with a bachelor's degree demonstrated significantly higher PK than those with only an associate degree, and teachers with longer experiences in teaching thinking had significantly higher TK-TT than those with fewer experiences. Stepwise regression further revealed that TPK-TT, TK-TT, and PK were significant predictors of in-service primary teachers' TPCK-TT. Implications for preparing teachers for teaching thinking were discussed."

Luo, W., Berson, I. R., & Berson, M. J. (2020). Integration of digital technology into an early childhood teacher preparation program in China. *Early Childhood Education Journal*. Advance online publication. https://doi.org/10.1007/s10643-020-01115-8

Abstract: "The rapid development of technologies has complicated its adoption and integration into early childhood teacher professional development in China. The government of China has developed policies and provided financial support to improve preschools' ICT infrastructure. Whereas various studies have examined the digital technology development provided to preservice educators around the world, relatively little is known about technology professional supports for early childhood (EC) preservice teachers in China's universities. In this research, we focus on a university in the central part of China as a case study to explore preservice teachers' technology use and self-efficacy while engaged in their field-based student teaching experiences. We collected data through an online questionnaire from 55 participants. Despite preservice educators' positive attitudes toward digital technologies, the results identified several issues that undermined EC preservice teachers' self-efficacy for technology use and limited their instructional practices integrating technology in the field. Nonetheless, with adequate supports, preservice teachers were more likely to develop high confidence in their practice, suggesting the importance of improving and upgrading the current teacher preparation program and opportunities for field-based implementation."

Macrides, E. & Angeli, C. (2020). Music cognition and affect in the design of technology-enhanced music lessons. *Frontiers in Education*, *5*, 518209. https://doi.org/10.3389/feduc.2020.518209

Abstract: "The present study addresses the lack of an instructional design methodology that guides the integration of technology in music listening and composition activities, and enriches the framework of Technological Pedagogical Content Knowledge (TPCK)—an essentially cognitive model– with the affective domain. The authors herein provide many examples that illustrate the music design principles and the expanded Technology Mapping instructional design process that have been proposed in previously published work. The practical examples provide concrete ideas on how to transform the musical materials into more understandable forms and how to associate them with emotions using technology. Besides its practical contribution, the research has also a theoretical significance for the theory of TPCK as it examines the interrelations between music content, technology, cognition, and affect,

and identifies discipline-specific aspects of TPCK that include the affective domain. The empirical evidence of 191 secondary school students presented within the context of a music composition task using the software Muse Score, supports that both the TPCK framework as well as the proposed music guidelines can effectively guide teachers in designing lessons with technology while incorporating effect. Through the 4E perspective, technology and the proposed approach are viewed as agents of a distributed system that can support the embodied minds to develop musical and emotional understanding."

Makawawa, J. C., Mustadi, A., Van Septriwanto, J., Sampouw, F., & Najoan, R. A. O. (2021). Primary school teachers' perception of technological pedagogical content knowledge in online learning due to COVID 19. *Jurnal Prima Edukasia*, *9*(1), 2021, 85-95. https://doi.org/10.21831/jpe.v9i1.35245

Abstract: "Primary school teachers need to have technological knowledge, pedagogical knowledge, and content knowledge in online teaching. TPACK is an integrative and transformative knowledge that teachers need to use technology effectively and efficiently in the classroom. This article investigates primary school teachers' perceptions of Technological Pedagogical Content Knowledge (TPACK) competencies in implementing online learning due to the pandemic COVID-19. The sample in this study were 117 primary school teachers in North Sulawesi province. The method used is a quantitative descriptive approach. Data was collected using a questionnaire on a Likert scale developed in Google Form. The results showed that most primary school teachers in North Sulawesi, Indonesia, already had TPACK competencies in online learning during the COVID-19 pandemic. Even so, TPACK competencies are in need to be improved in the abilities of TK and PK. The correlation results between the TPACK constructs also showed that the PK and TPK components had a significant effect on TPACK primary school teachers' perception of online learning. It was also found that there was no significant difference between gender and TPACK competency of primary school teachers."

Malik, K. & Lambert, J. (2020.) Exploring 1:1 iPad integration practices through a TPACK-in-practice lens," International Journal of Educational Technology and Learning, 9(1), 19-38. https://doi.org/10.20448/2003.91.19.38

Abstract: "The TPACK-in-Practice framework of Jaipal and Figg (2013) provides concrete practices that exemplify successful technology integration of teachers. This framework and mixed methods were used to examine the instructional practices of four teachers in a high school where 1:1 iPad integration had been implemented. Findings revealed that three teachers were successful at exhibiting instructional practices considered essential for effective technology integration. One of the teachers, however, only used technology to improve her productivity and therefore, did not see the value in integrating technology in any substantive way in the classroom. The successful teachers transitioned to more student-centered approaches with iPads being used as cognitive tools rather than for productivity purposes only. They were more accepting of risks and became more confident and apt to experiment with a variety of iPad applications. Successful experiences with iPad integration tended to increase motivation and confidence, which led to more integration experimentation."

Manalastas, J. P. (2020). Digitalized instructional materials in creative writing based on technological pedagogical content knowledge. *Journal of Humanities and Education Development*, *2*(2), 119-128. https://doi.org/10.22161/jhed.2.2.7

Abstract: "The main objective of the study was essentially focused on determining the effective ways in teaching creative writing among the Grade 11 Humanities and Social Sciences (HUMSS) students based on the Technological Pedagogical Content Knowledge (TPACK) in utilizing and developing digitalized instructional materials. A Quasi-Experimental research design was specifically utilized for one group shot. The creative writing teacher employed the digitalized resources in teaching creative writing covered for the semester after administering pretest to improve the writing skills of the students. Data collection was limited to pretest and posttest scores of the subjects using Paired T-test dependent among the students taking up the creative writing subject. This research concluded that there is significant difference in teaching creative writing of HUMSS students using digitalized materials. Using various tools available online and electronic resources can help and enrich students' creative writing abilities towards independent learning. Thus, writing opportunities can take place everywhere both in the classroom and at home."

Maniraho, J. F., Mutarutinya, V., & Njiku, J. (2020). Developing technological pedagogical content knowledge survey items: A review of literature. J*ournal of Digital Learning in Teacher Education*, *36*(3), 150-165. https://doi.org/10.1080/21532974.2020.1724840

Abstract: "This review of the literature analyzed twenty-eight survey instruments that were designed and validated by different researchers in order to measure teachers' technological pedagogical content knowledge. The analysis was done to find out the nature and synthesis of survey items across domains of the technological pedagogical content knowledge framework. The review showed that researchers design items differently across subscales, being either specific or broad in content, teaching approaches or technologies knowledge and their interactions. The logical pick up of concepts in the items from the primary technology, pedagogy and content domains to their complex interactions was only seen in few scales. We provide suggestions derived from the review for designing survey items that capture teachers' knowledge of technology integration in teaching while addressing specific content, pedagogy, and technology. We also recommend the logical relationship interlinking concepts in the three basic domains into their interactions that form complexities of teacher knowledge."

Martin, D. A., McMaster, N., & Carey, M. D. (2020). Course design features influencing preservice teachers' self-efficacy beliefs in their ability to support students' use of ICT. *Journal of Digital Learning in Teacher Education*. Advance online publication. https://doi.org/10.1080/21532974.2020.1781000

Abstract: "This study explores how using action plans, SMART goals, personal learning networking and peer teaching in a first-year education technology course influence pre-service teachers' (PSTs') self-efficacy beliefs in their technological pedagogical knowledge (TPK) and technological content knowledge (TCK). Pre- and post-course survey items from the *Teaching*

Teachers for the Future project were administered to examine PSTs' judgements of their self-efficacy to support students' use ICT in the classroom, including digital and robotics technologies. Results showed a significant increase in PSTs' confidence in using ICT in the classroom with the strongest effect-size for supporting students' use of robotics and digital technologies ($r > 0.5$). Course design features are discussed with reference to the corresponding impact on PST self-efficacy with recommendations for improvements to practice."

McClure, J., & Pilgrim, J. (2021). Implementing a 1:1 technology program in a rural, public school: A study of perceptions of technology integration. *Journal of Research on Technology in Education*. Advance online publication. https://doi.org/10.1080/15391523.2020.1852455

Abstract: "Rural communities face unique challenges that can complicate techno-logical integration and impact the effectiveness of 1:1 technology initiatives. The purpose of this qualitative study is to explore teachers' and administrators' perceptions of technology integration after implementing a1:1 initiative in a rural, public district. Three primary themes emerged. First, the combination of technology and pedagogy is an essential part of 1:1program success. Secondly, technology must be combined with content knowledge. Finally, there are benefits and challenges of rural settings. Students gain experiences, and schools see increased student engagement. However, lower levels of connectivity and longer bus rides impact students' ability to complete their work. Support received at home is impacted by parental hesitancy and a lower level of technical ability of the parents."

Meroño, L., Calderón, A., & Arias-Estero, J. L. (2021). Digital pedagogy and cooperative learning: Effect on the technological pedagogical content knowledge and academic achievement of pre-service teachers. *Revista de Psicodidáctica (English ed.)*, *26*(1), 53-61. https://doi.org/10.1016/j.psicoe.2020.10.002

Abstract: "Given the growing role of digital technology and its relevance in the national curriculum, the design and enactment of aligned pedagogies is a challenge for the community of teacher education. This research aims to explore: (a) whether Technological Pedagogical Content Knowledge (TPACK) model and cooperative learning (CL) facilitate preservice teachers' perception of TPACK and academic achievement; and (b) whether there is a relationship between preservice teachers' perception of TPACK and their academic achievement. A quasi-experimental pretest–posttest design with three groups (n=293) was performed for 15 weeks. One group has experienced a pedagogical approach based on TPACK and small-group work. A second group experienced a pedagogical approach based on TPACK and CL. A control group experienced a teacher-centered pedagogical approach and individual assignments. Main findings show that the two experimental groups improved their perception of TPACK and their academic achievement. However, statistically significant improvements were found favoring the group that experienced TPACK and CL. The prediction model also showed that TPACK predicted the academic achievement of pre-service teachers who also experienced TPACK and CL. In summary, digital pedagogies based on TPACK and CL improve pre-service teachers' TPACK and academic achievement. The use of these pedagogies could influence the development of

the digital competence of future teachers. Increasing the digital competence of future teachers is indeed a crucial aspect, given the current social and pedagogical scenario."

Mishra, P., & Warr, M. (2021). Contextualizing TPACK within systems and cultures of practice. *Computers in Human Behavior*, *117*, 106673. https://doi.org/10.1016/j.chb.2020.106673

Abstract: "Highlights:
• TPACK does not exist in a vacuum.
• Systems and cultures can define or constrain the kinds of moves teachers can make in pedagogical space.
• We define 5 spaces for intentional design (artifacts, processes, experiences, systems and culture).
• Teachers need to go beyond artifacts, processes and experiences to think of systems and culture if they are to succeed.
• This also has implications for future research and practice."

Morsid, N. A., Salleh, S. M., & Shahrill, M. (2020). Students' conceptions of learning using animations. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, *8*(2), 319-334. https://doi.org/10.24815/jpsi.v8i2.16370

Abstract: "This study explored the integration of animations in lessons designed using the Technological, Pedagogical, Content Knowledge (TPACK) framework to enhance students' conceptual understanding in the processes of diffusion and osmosis. The study was conducted in a secondary school involving 22 Year 12 students. Data was collected using the Osmosis and Diffusion Conceptual Assessment (ODCA), which is a two-tier diagnostic test administered before and after the lessons. The lessons were designed using an action research cycle, integrated with the TPACK matrix. There were four cycles to address the students' knowledge dimension, which scaffolds from lower order thinking to higher order thinking (declarative, procedural, schematic and strategic). The paired sample t-test was used to analyse the data and the findings revealed significant differences in the students' conceptual understanding after the animation-integrated lessons were carried out. The intervention was successful as proven from the large effect size, together with the increased frequency of students having selected the correct responses in the ODCA."

Mulyadi, D., Wijayatingsih, T., Budiastuti, R. E., Ifadah, M., & Aimah, S. (2020). Technological pedagogical and content knowledge of ESP teachers in blended learning format. *International Journal of Emerging Technologies in Learning*, *15*(6), 124–139. https://doi.org/10.3991/ijet.v15i06.11490

Abstract: "The onslaught of technology in language learning necessitates ESP teachers to enhance their teaching quality by integrating technology, pedagogy, and subject matters. To this end, the present research was an effort to discern Technological Pedagogical and Content Knowledge (TPACK) of ESP teachers in a blended learning format. A modified online survey comprising 28 closed-ended questions were administered to 70 ESP instructors of nursing

purposes from 35 Universities in Indonesia. The data were analyzed statistically to be depicted in descriptive statistics (percentages of frequencies, means, and standard deviations). As a result, three out of four TPACK subdomains, including technological content knowledge (TCK), and Technological Pedagogical Knowledge (TPK), Technological Pedagogical and Content Knowledge (TPACK) have been mastered by most ESP teachers. However, they have to improve their pedagogical content knowledge (PCK). The current research also contributes some empirical insights into how ESP teachers can construct the overarching ESP instruction in English for nursing purposes integrating TPACK."

Ng, O., & Chan, T. (2021). In-service mathematics teachers' video-based noticing of 3D printing pens "in action". *British Journal of Educational Technology*, *52*(2), 751–767. https://doi.org/10.1111/bjet.13053

Abstract: "We adopt five observation categories, namely classroom management, classroom environment, communication, mathematical content and tasks, to analyse four in-service secondary mathematics teachers' noticing upon watching video episodes showing an actual mathematics lesson that implemented 3D Printing Pens for teaching and learning shape and space. We use coding to analyse what the participants generally identified as important or noteworthy in the video. Moreover, we employ thematic analysis to delve deeper into the participants' interpretations and decisions in relation to using 3D Pens for teaching and learning mathematics. Our findings have implications for teachers' professional development in the area of technology integration especially in terms of their realisation of the affordances of novel-to-them technologies. We also report methodological and conceptual contributions towards teacher noticing."

Ng, K., Klavina, A., Ferreira, J. P., Barrett, U., Pozeriene, J., & Reina, R. (2021) Teachers' preparedness to deliver remote adapted physicaleducation from different European perspectives: Updates to the European standards in adapted physical activity. *European Journal of Special Needs Education*, *36*(1), 98-113. https://doi.org/10.1080/08856257.2021.1872848

Abstract: "When schools were closed due to the COVID-19 restrictions, tea-chers were challenged to engage children with Special Educational Needs (SEN) through remote teaching, particularly in physical edu-cation. The European Standards in Adapted Physical Activity (EUSAPA) have been used to define the competencies of adapted physical education (APE) teachers. Through a consensus building exercise, the standards were updated in this paper to include technologically supported pedagogy. Evidence from 125 APE tea-chers, who completed a technological communication inventory, modified versions of the technology, pedagogy and content knowl-edge scale (TPACK-21), and self-efficacy on including students with disabilities in physical education scale (SE-PETE-D), were used to inform experts to create technological indicators for the EUSAPA. Teachers used 3 to 4 technologies (email, phone, SMS, Whatsapp) to communicate with students and colleagues, and many reported low levels of technological content knowledge. Experts considered the need to add 13 new functions to the EUSAPA. Most of the functions were considered to be feasible to implement in existing practices and the other

requiring extra resources or skills. As further training is planned, consideration of expertise is warranted when mapped against meeting standards."

Nkosingiphile Mazibe, E., Gaigher, E., & Coetzee, C. (2020). Comparing pedagogical content knowledge across fundamental concepts of electrostatistics: A case of three preservice teachers. *African Journal of Research in Mathematics, Science and Technology*, 24(2), 143-155. https://doi.org/10.1080/18117295.2020.1765607

Abstract: "It has recently been suggested that pedagogical content knowledge (PCK) has a concept-specific nature, beyond the topic-specific level of PCK. This paper reports a case study of three pre-service teachers' reported PCK about three fundamental concepts within the topic of electrostatics, namely electrostatic force, electric field and electric field strength. The aim of the study was to compare the quality of the PCK of each of the individual participants across these fundamental concepts. Data was collected using a content representation tool and a lesson planning form prescribed by the participants' teacher training institution. A topic-specific PCK model was adopted as the framework for this study. The model asserts that the content of a particular topic is transformed for instruction through five components, namely learners' prior knowledge, curricular saliency, what is difficult to teach, representations including analogies and conceptual teaching strategies. Guided by the model, we designed a rubric to assess the concept-specific PCK of the participants on a four-point scale. The results of the study indicated that the PCK of the participants varied across the fundamental concepts of electrostatics, with each participant reporting better PCK for a different concept. The results of the study imply that describing PCK at concept level is appropriate and recommend that PCK should be strengthened at concept level during teacher training to ensure that it develops across all of the concepts within a topic."

Nurhadi, M., & Darhim. (2020). Analysis: The ability of thinking abstractly of mathematics and self-efficacy through TPACK. *Journal of Physics: Conference Series*, *1764* (2021), 012122. https://doi.org/10.1088/1742-6596/1764/1/012122

Abstract: "The purpose of this study is to analyze the ability of thinking abstractly of mathematics and self-efficacy through TPACK learning. This research is quantitative with survey method and conducted on 7th grade students. The Data were collected using interview, questionnaire sheets and the ability thinking abstractly of mathematics tests. The results of this study are several indicators of the ability of thinking abstractly of mathematics, found indicators that have been achieved but some of them have not yet been reached as making generalizations. The results of the questionnaire and interview it was concluded that most students still assume that mathematics is difficult to learn and the ability ."

Oktamarsetyani, W., & Paidi (2019). The analysis ability of technological content knowledge (TCK) of biology education's students in Universitas Ahmad Dahlan in preparation of learning plan. *Jurnal Bioedukatika*, *7*(2), 107–144. http://doi.org/10.26555/bioedukatika.v7i2.12327

Abstract: "Technological Content Knowledge is the student's (prospective biology teachers) knowledge in determining certain technologies that will be used in the learning process. This knowledge is important for prospective teachers because it can help students in understanding the material that has been conveyed. The objective of this study is to examine the ability of Technological Content Knowledge (TCK) of biology education students in preparing learning plans. The study is a quantitative descriptive research by using survey method. Participants of this study are all biology education students a total of 120 students in the Faculty of teacher training and education in Universitas Ahmad Dahlan 6th semester academic year 2017/2018. Data collection techniques use a non-test instrument of the learning plan document observation sheet and the instrument on the written tests about technological knowledge and biological content. The data obtained is statistically analyzed in a descriptive form intended to figure out the capabilities of the TCK's student. In order to the acquired results can be trusted and reduce subjectivity, a compatibility test is conducted between panelists. The results showed that: (1) biology education students have TCK ability which is less than reviewed for learning plan, (2) biology education students have TCK skills worth in terms of written test result about TCK knowledge."

Oladosu, K. K., Abdel-Aziz, A. A., Ibironke, E. S., Alasan, N. J., & Makanjuola, T. W. (2020). Pre-service teachers perceived technological, pedagogical, content knowledge and self-efficacy on the use of information and communication technology. *International Journal of Innovative Technology Integration in Education*, *4*(1), 61–69.

Abstract: "The study was carried out to determine Pre-Service Teachers perceived knowledge and self-efficacy on the use of information and communication at the University of Ilorin. The study adopted a descriptive research design of the survey type to elicit relevant information from the respondents. The population for the study comprised all Pre-Service Teachers in the Faculty of the Education University of Ilorin. Purposive sampling was employed to select 400 Level Pre-Service Teachers because they have undergone various types of teacher training and information and communication technology courses and have also undergone the mandatory teaching practice exercise. A total of 150 respondents returned their questionnaire for analysis out of 200 questionnaires administered. The findings of the study revealed that respondents have adequate knowledge about Technological Knowledge, Content Knowledge Pedagogical Knowledge and Self-Efficacy with mean scores of 3.25, 3.40, 3.37 and 3.28 respectively > 2.50. The hypotheses tested revealed that there was no significant difference between technical knowledge and self-efficacy (t= 0.93, P >.05,) there was no significant difference between pedagogical content and self-efficacy (t = 0.45 >.05). The study recommended that pre-service education should be more ICT driven as this will facilitate ICT utilization during teaching practice and beyond."

Othman, N., & Maat, S. M. (2020). TPACK framework based research in mathematical education: A systematic literature review. *International Journal of Academic Research in Business and Social Sciences*, *9*(2), 156–169. http://dx.doi.org/10.6007/IJARPED/v9-i2/7284

Abstract: "This systematic literature review aims to identify the themes of the study on the Technology Pedagogical Content Knowledge (TPACK) framework in mathematics education and the research methods used in the studies. The search for articles published from year 2015 to 2020 was conducted through the Google Scholar electronic database. A total of 30 articles were selected. The results show that researchers are more focused on studying the level and effectiveness of technology integration in mathematical learning. Over 50% of the research has been done on teachers compared to students and lecturers in the field of mathematics. The findings also show that technology integration in teaching fraction and algebra is the most frequently studied. Qualitative research method is the dominant research methodology used to study the research objectives regarding the TPACK framework, compared to the quantitative method and the mixed method. Limitations and suggestions for further studies are also discussed."

Özgür, H. (2020). Relationships between teachers' technostress, technological pedagogical content knowledge (TPACK), school support and demographic variables: A structural equation modeling. *Computers in Human Behavior*, *112,* 1-9. https://doi.org/10.1016/j.chb.2020.106468

Abstract: "The proliferation of information technology products and services in learning environments as a result of rapid innovation leads to a greater requirement of meticulous planning in integration processes. In this regard, the burden placed upon teachers within their classroom increases. This phenomenon, referred to as technostress, has recently been studied extensively in terms of its causes and negative effects. However, there is not much research into factors that contribute to the alleviation of technostress of teachers. This study employs statistical structural equation modeling (SEM) in order to examine the causal relationships among certain variables that are thought to relieve technostress, over data collected from 349 in-service high school teachers in Turkey. Results of the modeling effort indicate that both school support and teachers' technological-pedagogical content knowledge (TPACK) negatively predict their technostress level."

Paulus, M. T., Villegas, S. G., & Howze-Owens, J. (2020). Professional learning communities: Bridging the technology integration gap through effective professional development. *Peabody Journal of Education*, *95*(2), 193–202. https://doi.org/10.1080/0161956x.2020.1745610

Abstract: "While technology is prevalent in American classrooms, meaningful technology integration remains an issue, indicating a lack of effective professional development. Unlike the typical workshop model, professional learning communities (PLCs) utilize teacher-centered approaches to professional development. Kolb's experiential learning theory, Bandura's self-efficacy theory, and the expectancy-value model work together to provide the theoretical foundation supporting professional development through PLCs. This article proposes a plan for transformative technology integration using a PLC model for professional development."

Pittalis, M. (2020). Extending the Technology Acceptance Model to evaluate teachers' intention to use dynamic geometry software in geometry teaching. *International Journal of Mathematical Education in Science and Technology*. Advance online publication. https://doi.org/10.1080/0020739X.2020.1766139

Abstract: "The purpose of this study was twofold. Firstly, to extend the Technology Acceptance Model (TAM) to assess secondary mathematics school teachers' intention to use Dynamic Geometry Software (DGS) in geometry teaching and, second, to examine the relations between the parameters of TAM and the role of external variables. We extended TAM by integrating in the model the notion of 'perceived pedagogical-learning fit', which refers to evaluating the pedagogical learning appropriateness of teaching geometry with DGS based on a cognitive-learning model. The results of the study showed that perceived pedagogical-learning fit and attitude are the strongest predictive factors of intention to use a DGS in geometry teaching. The perceived usefulness did not significantly affect their intention to use it. Personal innovation, facilitating condition and computer anxiety had weak to moderate effects on perceived pedagogical-learning fit and perceived ease of use, and indirect effects on intention to use."

Polly, D., & Byker, E. (2020). Considering the role of zone of proximal development and constructivism in supporting teachers' TPACK and effective use of technology. *Revista de Educación a Distancia*, *20*(64), article 5. http://dx.doi.org/10.6018/red.408661

Abstract: "This article examines Vygotsky's (1978) Zone of Proximal Development (ZPD) and Tharp and Gallimore's (1988) application of ZPD for teacher learning that can be used as a framework to develop teachers' and teacher candidates' Technological Pedagogical Content Knowledge (TPACK). We synthesize these ideas and provide vignettes from both teachers and teacher candidates that describe how ZPD can inform the way teachers' TPACK is developed. We argue that the stages of ZPD (Tharp & Gallimore, 1988) provide a helpful framework for the development of teacher candidates' and in-service teachers' TPACK through experiential learning opportunities that include the reflection of the intersection of technologies, pedagogies, and content knowledge. The implication of our paper includes a call for long-term systematic examinations of strategies to support teachers and teacher candidate development of TPACK."

Rachbini, W., Rachmadtullah, R., & Susanto, R. (2020). Technological and pedagogical models: Analysis of factors and measurement of learning outcomes in education. *Journal of Ethnic and Cultural Studies*, *7*(2), 1-14. http://doi.org/10.29333/ejecs/311

Abstract: "The era of the industrial revolution 4.0 emphasizes the importance of the digital literacy elaboration that links the full technological and pedagogical capabilities to enhance learning outcomes in all three domains that include knowledge, skills and attitudes. Much is needed of factor analysis and measurement studies that touch on aspects of pedagogy and technology as an indicator analysis of pedagogical competency development models. The method used is a quantitative approach, data analysis technique is done through the Goodness of-Fit criteria. The stages of modeling and analysis of structural equations in the analysis of first

and second measurement models are performed with CFA and using SEM as a tool. Data analysis was also carried out to analyze indicators that predominantly influenced learning outcomes. The results of the study concluded that the Technological and Pedagogical Model was a factor and measurement of learning achievements in education."

Ramos, R. A., Babasa, E. E., Vergara, I. B., Manalo, B. I., Gappi, L. L., & Morfi, T. G. (2020). The TPACK confidence of pre-service teachers in selected Philippine teacher education institutions. *International Journal of Education, Psychology and Counseling*, *5*(37), 196-205. https://doi.org/10.35631/IJEPC.5370016

Abstract: "The changing educational landscape of Philippine education in the past decade poses challenges to the implementers of the curriculum innovations –the teachers. Consequently, this has put more pressure on the teacher education institutions (TEIs) to produce a quantity of quality teachers. From this context, this paper examines the technological, pedagogical, and content knowledge (TPACK) confidence level of pre-service teachers in selected Philippine teacher education institutions. The TPACK Model has been a very useful framework for academic stakeholders to understand and measure the level of technology integration in teaching and learning. Using a 64-item self-diagnostic questionnaire designed to measure the dimensions of TPACK in terms of learning experience and practice, and assessing the responses of 187 graduating pre-service teachers from selected Philippine TEIs, the data suggest that the pre-service teachers are fairly confident with the learning experience they get from the TEIs and that by using these experiences they frequently demonstrate the acceptable teacher competency and standards. Furthermore, the levels of TPACK confidence of the secondary and elementary pre-service teachers significantly differ from each other such that the former are more confident with their learning experience and practice. Data also show that there is a significant relationship between the quality of learning experience and the ability of the pre-service teachers to demonstrate the core competencies of TPACK. Hence, teacher education institutions must consider innovating their curriculum through training, subject-focused pedagogical modeling, and subject-specific technologies."

Rauf, A. A., Swanto, S., & Salam, S. N.(2021). Exploratory factor analysis of TPACK in the context of ESL secondary school teachers in Sabah. *International Journal of Education, Psychology and Counseling*, *6* (38), 137-146. http://www.ijepc.com/PDF/IJEPC-2021-38-03-12.pdf

Abstract: "Despite the fact that plenteous studies on educational technology and strategic domain have been conducted, various studies indicated that EFL teachers do not explore the full potential of information and communication technology (ICT) in their classroom. It requires EFL teachers‟ consideration to be able to intensify their knowledge, which emphasizes the understanding on how technology development nowadays may encourage the improvements of language learning, and it may change the professional teachers‟ roles and practices. In order to help EFL teachers integrate modern technology into their EFL classroom, EFL teachers need to understand better the fundamental elements that may foster technology integration.

Technological Pedagogical Con-tent Knowledge (TPACK) is a framework for understanding the varied forms of knowledge necessitated by EFL teachers to integrate ICT in their teaching. This study aimed to investigate how EFL teachers" perceptions of competences in their TPACK development. Hence, this study used a case study since it was an appropriate method in conducting the research. The data were collected from 20 EFL teachers by conducting online semi-structured interviews. The findings indicated that most EFL teachers rated their domain knowledge high-er about CK, PK, and PCK rather than those domains concerned with techno-logical knowledge, i.e., TK, TCK, TPK, and TPACK. The implication of this research is to add EFL teachers" understanding of the importance of the TPACK framework. In the future, it takes part in developing the competence of EFL teachers" TPACK development so that the quality of the teaching-learning process promotes."

Reyna, J., Hanham, J., Vlachopoulos, P., & Meier, P. (2020). Using factor analysis to validate a questionnaire to explore self-regulation in learner-generated digital media (LGDM) assignments in science education. *Australasian Journal of Educational Technology*, *35*(5), 128–152. https://doi.org/10.14742/ajet.4514

Abstract: "This research is a validation study of a survey instrument to assess student self-regulation which aims to fill a methodological gap by capturing self-regulation processes while completing learner-generated digital media (LGDM) assignments. For this purpose, the study developed and validated a self-regulation learning questionnaire. Data were gathered from seven science subjects (Years 1 to 3, *n* = 341) which used LGDM assignments during Semester 1, 2017. Students were asked to complete a 40-item online questionnaire. The questionnaire was administered at three times during the semester (Weeks 2, 6, and 10). Exploratory factor analysis was used to identify factor structures, followed by confirmatory factor analysis to test the validity of the constructs defined by exploratory factor analysis. Analysis of the data revealed a ten-factor structure – six concerning self-regulation, two concerning student attitudes towards LGDM assignments, one concerning assignment ownership, and one concerning assignment motivation. The variables empirically verified in this study have important practical implications, as they could provide educators with the direction in which to target interventions to improve learners' experiences with LDGM. The study findings also contribute to the field by providing scholars with a validated research instrument that can be used in future studies."

Rice, M. F., & Deschaine, M. E. (2020). Orienting toward teacher education for online environments for all students. *The Educational Forum*, *84*(2), 114–125. https://doi.org/10.1080/00131725.2020.1702747

Abstract: "The online environment is an expansive educational context distinct from the traditional one. We problematize the current online teacher education landscape and make recommendations for practices that prepare and support teachers as online teachers, rather than teachers who periodically use Internet resources and digital devices for instruction. Recommendations focus on personalization, collaboration, administrative support, program

(re)designs, new models of technological integration, attention to standards for teaching and learning, and ongoing professional learning opportunities."

Rodriguez-Becerra, J., Caceres-Jensen, L., Diaz, T., Druker, S., Padilla, V. B., Pernaa, J., & Aksela, M. (2020). Developing technological pedagogical science knowledge through educational computational chemistry: A case study of pre-service chemistry teachers' perceptions. *Chemistry Education Research and Practice*, *21*(2), 638-654. https://doi.org/10.1039/c9rp00273a

Abstract: "The purpose of this descriptive case study was to develop pre-service chemistry teachers' Technological Pedagogical Science Knowledge (TPASK) through novel computational chemistry modules. The study consisted of two phases starting with designing a computational chemistry based learning environment followed by a case study where students' perceptions towards educational computational chemistry were explored. First, we designed an authentic research-based chemistry learning module that supported problem-based learning through the utilisation of computational chemistry methods suitable for pre-service chemistry education. The objective of the learning module was to promote learning of specific chemistry knowledge and development of scientific skills. Systematic design decisions were made through the TPASK framework. The learning module was designed for a third-year physical chemistry course taken by pre-service chemistry teachers in Chile. After the design phase, the learning module was implemented in a course, and students' perceptions were gathered using semi-structured group interviews. The sample consisted of 22 pre-service chemistry teachers. Data were analysed through qualitative content analysis using the same TPASK framework employed in the learning module design. Based on our findings, pre-service chemistry teachers first acquired Technological Scientific Knowledge (TSK) and then developed some elements of their TPASK. Besides, they highly appreciated the combination of student-centred problem-based learning and the use of computational chemistry tools. Students felt the educational computational learning environment supported their own knowledge acquisition and expressed an interest in applying similar learning environments in their future teaching careers. This case study demonstrates that learning through authentic real-world problems using educational computational methods offers great potential in supporting pre-service teachers' instruction in the science of chemistry and pedagogy. For further research in the TPASK framework, we propose there would be significant benefit from developing new learning environments of this nature and evaluating their utility in pre-service and in-service chemistry teacher's education."

Saienko, N., Lavrysh, Y., & Lukianenko, V. (2020). The impact of educational technologies on university teachers' self-efficacy. *International Journal of Learning, Teaching and Educational Research*, *19*(6), 323-336. https://doi.org/10.26803/ijlter.19.6.19

Abstract: "The teaching profession is always evolving. Teachers have to upgrade their knowledge and skills to be in line with students' and employers' needs. The challenges teachers are facing are the continuously changing conditions of the teaching process and technological innovations. Unsuccessful and numerous attempts to overcome these challenges negatively affect teachers' self-efficacy. The purpose of the study

was to investigate the impact of educational technologies on university teachers' self-efficacy level changes using quantitative (pre and post-self-efficacy test) and qualitative (peer-observation, interviews) research methods. The study involved 60 in-service ESP teachers with different length of teaching experience. Teachers were exposed to a short practical course on technologies integration into the teaching process, and after that, they had to demonstrate the practical application of the knowledge obtained. The findings showed that educational technologies integration had positive influence on four components of teachers' self-efficacy: classroom management, instruction strategies design, students' engagement and technologies integration. During the course delivery, we dealt with two problems: computer anxiety (senior teachers), as well as technology and pedagogical content knowledge framework (novice teachers)."

Sailer, M., Stadler, M., Schultz-Pernice, F., Franke, U., Schoffmann, C., Panitova, V., Husagic, L., & Fischer, F. (2021). Technology-related teaching skills and attitudes: Validation of a scenario-based self-assessment instrument for teachers. *Computers in Human Behavior*, *115*(2021), 106625. https://doi.org/10.1016/j.chb.2020.10662

Abstract: "Instruments that assess teachers' skills and attitudes on the basis of a broad range of specific standards and demands for teaching with digital technologies are lacking to date. Based on the K19 framework, we validated the scenario-based instrument IN.K19 that simultaneously assesses technology-related teaching skills and attitudes via self-assessment. In our study with N = 90 teachers and student teachers with teaching experience, we demonstrate that the instrument has satisfactory factorial validity in our confirmatory factor analyses. To investigate its predictive validity, we examined the instruments' relationships with teachers' frequency of technology use in class and teachers' initiation of different types of student learning activities involving technology. Results from structural equation modelling show relationships between self-assessed skills in different phases of teaching with technology and the self-reported initiation of student learning activities involving overt actions (active, constructive, and interactive learning activities), supporting the predictive validity of our instrument. Positive attitudes towards technology-related teaching also exhibit positive relationships with the initiation of learning activities involving digital technologies, but more specifically learning activities that do not include observable actions by learners (passive learning activities). Thus, teachers' self-assessed technology related skills rather than attitudes might contribute to facilitating learning activities crucial for students' learning."

Sánchez-Ibáñez, R., Guerrero-Romera, C., & Miralles-Martínez, P.. (2021). Primary and secondary school teachers' perceptions of their social science training needs. *Humanities and Social Sciences Communications*, *8*(1). https://doi.org/10.1057/s41599-021-00705-0

Abstract: "Competency-based education is one of the challenges currently faced by social science teachers. At present, there is an abundance of research on competencies relating to the social sciences which favour the development of historical thinking among learners. The ongoing training of teachers is of vital importance when it comes to shifting the method of

teaching towards approaches which focus more on the learner, which favour the teaching of historical contents and competences aimed at forming a critical citizenship. For this reason, the two objectives of this study are to discover which disciplinary contents are considered by teachers to be most relevant for the teaching of history and what training is required by teachers who give social science classes in primary and secondary education in Spain. The research is anon-experimental mixed-methods study. In order to achieve the first objective, a quantitative analysis has been carried out of the data obtained from a questionnaire with a Likert-type scale administered to 332 primary and secondary teachers in Spain. To achieve the second objective, the information obtained from 12 interviews with primary and secondary schoolteachers in Spain has been analysed in a qualitative way. The results obtained indicate that teachers update their disciplinary knowledge via scientific journals and that they are interested in receiving training in historical thinking skills, active learning methods and ICT resources. Based on these training needs, it is concluded that teachers currently envisage at eaching model in the social sciences which is more competency-based and focused on the active participation of the learner."

Sari, Y. R. (2020). Reflection as a way to grapple TPACK complexity for EFL teachers. *Budapest International Research and Critics in Linguistics and Education, 3*(2), 894-903. https://doi.org/10.33258/birle.v3i2.981

Abstract: "Technological Pedagogical Content Knowledge (TPACK) is a framework to develop the theory to practice in teaching with technology. Therefore, the teacher, as a practitioner of TPACK implementation, has a responsibility to implement the knowledge effectively. This study investigates the meta-cognitive awareness produced by teachers who participate in TPACK lesson design workshops. This process involves some reflection tools, focus group discussion, and reflective journal as a platform for doing the reflection. This study documented teachers' stories during three interviews as they created their TPACK lesson design. The detailed data was from three Indonesian teachers. Those teachers participated in the process of research from the professional development workshop to the focus group interview. The data indicated the details of their experience in reflecting and determining on their professional knowledge. These findings show that during the reflection, the teachers start to realize each aspect of TPACK in three stages. These findings are useful for the government to establish professional development workshops in the technology education field. The researcher explored the implications of this analysis for teachers to effectively design the lesson and future researchers."

Sasota, R. S., Cristobal, R. R., Sario, I. S., Biyo, J. T., & Magadia, J. C.. (2021). Will–skill–tool (WST) model of technology integration in teaching science and mathematics in the Philippines. *Journal of Computers in Education*. Advance online publication. https://doi.org/10.1007/s40692-021-00185-w

Abstract: "The proliferation of information and communication technologies (ICT) in the twenty-first century has challenged the status quo of educational setting and led to a paradigm shift in teaching and learning processes. ICT use and integration in teaching then,

becomes an essential component of pedagogical processes to have an effective teacher–student interaction and to optimize learning. While past studies have already established evidence that attitude toward ICT (will), ICT skills (skill), and availability of ICT resources (tool) elements are indeed important contributors to the integration of ICT in teaching, little attention has been paid yet to differences in these elements and in this model of ICT integration between subject areas of sci-ence and mathematics. Thus, this study aims to examine the significant differences in these factors between science and mathematics (S&M) teaching guided by the Will–Skill–Tool (WST) model developed by Christensen and Knezek (2001, 2008). Using independent samples t test and multiple linear regression, results show that science teachers had higher scores in will, skill, tool, and ICT integration indices compared to mathematics teachers. Findings also revealed that WST model of ICT integration differs between science and mathematics areas, particularly in terms of which among the factors had the strongest influence on ICT integration. The study recommends distinct approaches in providing capacity training development on ICT integration for teachers considering the context of subject specific area."

Saubern, R., Henderson, M., Heinrich, E., & Redmond, P. (2020). TPACK – time to reboot? *Australasian Journal of Educational Technology*, 36(3), 1–9. https://doi.org/10.14742/ajet.6378

Abstract: "In this paper we explore and challenge the trajectory of research scholarship in the area of Technological, Pedagogical and Content Knowledge (TPACK). In doing so we adopt the position, as elaborated in Harris et al.'s (2017) editorial, that TPACK research is in need of addressing two key questions: What do teachers need to know in order to integrate technology effectively in the classroom and how can they best develop that knowledge? In order to explore this concern we undertook a review of research using the TPACK framework published in the Australasian Journal of Educational Technology over the last five years. The resulting 22 papers in which the TPACK framework was used substantially as a theoretical or methodological base for the research was analysed in regards to how TPACK scholarship is developing in relation to the research directions set out in the Harris et al.'s (2017) special edition editorial. The review concludes that much of the research identified focused on exploring, critiquing and validating the structure of the TPACK diagram and the seven components it describes. However, we argue that this focus has distracted researchers from addressing the key goals of TPACK and advancing understanding of effective teaching with technology. We conclude that there is a need for a fundamental shift in the trajectory of TPACK research, that is, to pay greater attention to understanding the knowledge that teachers need to use technology effectively for teaching and learning."

Saubern, R., Urbach, D., Koehler, M., & Phillips, M. (2020). Describing increasing proficiency in teachers' knowledge of the effective use of digital technology. *Computers & Education, 147*. https://doi.org/10.1016/j.compedu.2019.103784

Abstract: "This paper aims to contribute to the theoretical framing of Technological Pedagogical Content Knowledge (TPACK) by exploring how a measurement approach can be used to address

the need to improve the prescriptive value of the framework. Building on and extending the work described in Saubern, Urbach, Koehler and Phillips (2019), this paper describes the development of an empirically derived qualitative description of increasing proficiency in TPACK Confidence and TPACK Usefulness. Using the results of a partial credit Rasch analysis of survey responses, five bands of proficiency in TPACK Confidence and five bands of proficiency in TPACK Usefulness were delineated and described. The study found that teachers at higher levels of TPACK proficiency more strongly believe in the value of using technology to facilitate deep thinking and learning and are more confident to use technology to support and facilitate deeper thinking and learning in and across curriculum areas than teachers with lower levels of proficiency. By providing a description of lower and higher proficiency and an inferred typical order of acquisition, the resulting construct maps can be used by researchers to help develop and test hypotheses about teachers' acquisition of TPACK and improve the validity and precision of TPACK survey tools and by teacher educators to better understand and evaluate the TPACK of student teachers and inform the development of teacher education curricula."

Scherer, R., Siddiq, F., & Tondeur, J. (2020). Enhancing pre-service teachers' technological pedagogical content knowledge (TPACK): a mixed-method study. *Education Technology Research and Development, 68*, 319–343. https://doi.org/10.1007/s11423-019-09692-1

Abstract: "The main aim of this two-step mixed-method study was to explore the effectiveness of the strategies used to prepare pre-service teachers for technological pedagogical content knowledge (TPACK). Specifically, we focused on the strategies included in the synthesis of qualitative evidence (SQD) model: (1) using teacher educators as role models, (2) reflecting on the role of technology in education, (3) learning how to use technology by design, (4) collaboration with peers, (5) scaffolding authentic technology experiences, and (6) providing continuous feedback. To explore the relation between the perceived occurrences of the SQD-strategies and TPACK (controlled for pre-service teachers' general attitudes towards technology), survey data were collected from a sample of 688 final-year pre-service teachers in Belgium. In a next step, 16 telephone interviews and 6 in-depth interviews were conducted to gain a more in-depth insight into the nature of the 6 strategies and their influences on TPACK. The quantitative analyses indicated positive correlations between the SQD-strategies and TPACK, controlled for general attitudes towards technology. The findings from the qualitative analyses showed that teachers acknowledged the importance of the six strategies. However, the respondents emphasized that some of the six strategies are often underutilized. Based on the quantitative and qualitative results, the discussion provides recommendations to improve the potential of pre-service training to enhance future teachers' TPACK."

Schmid, M., Brianza, E., & Petko, D. (2020). Developing a short assessment instrument for Technological Pedagogical Content Knowledge (TPACK.xs) and comparing the factor structure of an integrative and a transformative model. *Computers in Education*, *157*(2020). https://dx.doi.org/10.1016/j.compedu.2020.103967

Abstract: "Technological Pedagogical Content Knowledge (TPACK) is regarded as one of the most important models describing teachers' competencies for successfully teaching with

technology. TPACK is most frequently assessed by means of self-report questionnaires, which beside their inherent methodological limitations present constraints related either to the validity, reliability, or prac-tical applicability of existing instruments. Furthermore, the internal structure of the TPACK framework is a topic of debate. The two goals of this study were (1) to develop a valid and reliable short questionnaire for measuring TPACK (TPACK.xs), and (2) to use this instrument to investi-gate TPACK's internal relations, assessing whether the framework reflects an integrative or a transformative view regarding how the TPACK knowledge domains interact. An initial ques-tionnaire of 42 items was administered to 117 pre-service upper secondary school teachers. Reliability analysis and confirmatory factor analysis were used to reduce the number of items per subscale and fit the model. Structural equation modelling investigated the internal relations be-tween components. Results show that the final TPACK.xs questionnaire, consisting of 28 items, can be considered a valid and reliable instrument for assessing pre-service teachers' TPACK. Furthermore, the internal relations of knowledge components support a transformative view of the TPACK model."

Schmid, M., Brianza, E., & Petko, D. (2021). Self-reported technological pedagogical content knowledge (TPACK) of pre-service teachers in relation to digital technology use in lesson plans. *Computers in Human Behavior*, *115*. https://doi.org/10.1016/j.chb.2020.106586

Abstract: "TPACK is a prominent model of teacher expertise for effectively teaching with digital technologies. While numerous studies have investigated teachers' TPACK by means of self-report surveys, its relation to more objective outcomes like lesson planning has only recently come into focus. The aim of this study was to investigate whether differences in use of digital technologies in lesson plans are related to self-reported TPACK. Lesson plans of 173 pre-service teachers were coded for whether or not they included the use of digital technologies as well as for whether this use was intended for teachers or students. Independent t tests and ANOVAs were used to compare individual TPACK components among groups. Subsequently, unique profiles of all TPACK components were identified using cluster analyses and investigated for group differences via cross tabulation. Logistic and multinomial regressions were conducted to investigate the relations between TPACK profiles and technology use controlling for gender, age, and subject group. Overall results showed no significant group differences for either individual TPACK components or for the two- and five-cluster solutions of TPACK profiles. Subject group emerged as the only significant predictor and STEM pre-service teachers showed positive relations of TPACK components and technology use in lesson plans."

Scott, K. C., & Nimon, K. (2020). Construct validity from a TPACK self-assessment instrument in 2-year public college faculty in the United States. *Journal of Research on Technology in Education*. Advance online publication. https://doi.org/10.1080/15391523.2020.1790444

Abstract: "Mishra and Koehler's technological pedagogical content knowledge (TPACK) theory can help provide the framework for measuring needed knowledge, skills, and abilities (KSAs) in faculty members at 2-year public colleges. This study tests a self-assessment survey in a large sample of 2-year public college faculty members. Using factor analysis, the Community College

TPACK Survey for Meaningful Learning (CC-TSML) is found to demonstrate internal reliability, adequate model fit, and composite reliability. Use of this instrument can help faculty members and administrators determine what type of interventions may be necessary to help faculty achieve the needed KSAs as measured by the CC-TSML, including professional development."

Segal, P., & Heath, M. (2020). The "wicked problem" of technology and teacher education: Examining teacher educator technology competencies in a field-based literacy methods course. *Journal of Digital Learning in Teacher Education*, *36*(3), 185–200. https://doi.org/10.1080/21532974.2020.1753600

Abstract: "This paper paints a complex portrait of the "wicked problem" of teaching technology integration in a field-based content literacy course in order to analyze how a teacher educator demonstrated a presence (and absence) of Teacher Educator Technology Competencies (TETCs). The study indicates that developing technology competencies in teacher educators shares challenges with broader issues of practice based teacher education. It suggests the TETCs would benefit from a clear grounding in theory and should consider the influence of teacher educator TPACK on teacher educators' abilities to build and demonstrate competency. Overall, framing teacher educator professional growth and development through the lens of the TETCs facilitated reflection and spotlighted areas of strength, as well as areas for improvement, within practice."

Septiyanti, M., Inderawati, R., & Vianty, M. (2020).Technological pegadogical and content knowledge (TPACK) perception of English education students. *English Review: Journal of English Education*, *8*(2), 1–10. https://doi.org/10.25134/erjee.v8i2.2114

Abstract: "Technological Pedagogical and Content Knowledge, abbreviated as TPCK or TPACK, is the interdependent, situated knowledge needed to integrate the use of digital tools and resources effectively in curriculum-based teaching. This study aims to find out the TPACK perception of English Education students at Lampung University, the way the students obtain TPACK in learning, and the role of lecturers in assisting the students to obtain TPACK in learning. By applying a mixed method, questionnaire and interview were used to gather the data. 225 English Education undergraduate students in academic year 2018/2019 and3 lecturers participated in this study. As result, the TPACK perception of the students was generally good as the score of all domains measured (Technological Knowledge/TK, Technological Content Knowledge/TCK, Technological Pedagogical Knowledge/TPK, Technological Pedagogical Content Knowledge/TPCK, and Technology-related Learning Experiences/TLE) was 722.1. Moreover, the students obtained TPACK by observing lecturers teaching in the classroom and doing self-learning with internet as media. Further, it was found that there were five roles of the lecturers in assisting the students to obtain TPACK in learning, namely provider, model, controller, facilitator, and motivator."

Setiawan, H., & Philipson, S. (2020). The correlation between social media usage in academic context and self-efficacy towards TPACK of prospective science teachers in Indonesia. *Journal of Science Learning*, *3*(2), 106–116. https://doi.org/10.17509/jsl.v3i2.22242

Abstract: "The purpose of this study is to investigate the relationship between the frequency of Social Media Usage (SMU) in an academic setting and Self-efficacy beliefs towards TK, TCK, TPK, and TPACK of Indonesian prospective science teachers. This research is quantitative based-research design using a self-administered survey. The research was conducted during the second semester of the academic year 2018/2019 from October to November 2018 in the Faculty of Mathematics and Natural Science of a State University located in Semarang City, Indonesia. The sample consists of 217 Indonesian prospective science teachers from the science and Biology Education Department. The result shows that the average Social Media Usage frequency has a statistically high correlation with TK Self-efficacy, TPK, and TPACK. However, in general, it does not correlate with TCK. Second, Social Media Usage for Download Media (DM), Searching Information (SI), and Entertainment and Motivation (EM) generally have a statistically medium correlation with TK, TPK, and TPACK for both male and female participants. Third, Social Media Usage for professional development (PD) has a medium correlation with TK and high correlation with TPK and TPACK. This study implies that training focuses on the application of social media in teaching, and learning should be integrated to improve Indonesian Prospective Science Teachers' TPACK."

Seufert, S., Guggemos, J., & Sailer, M. (2021). Technology-related knowledge, skills, and attitudes of pre- and in-service teachers: The current situaion and emerging trends. *Computers in Human Behavior*, *115*(2021), 106552. https://doi.org/10.1016/j.chb.2020.106552

Abstract: "This is the introductory article for the special issue "Technology-related knowledge, skills, and attitudes of pre and in-service teachers". It (1) specifies the concept of technology-related knowledge, skills, and attitudes (KSA) of teachers, (2) presents how these KSA are currently assessed, and (3) outlines ways of fostering them among pre- and in-service teachers. The eight articles in the special issue are structured accordingly, and we demonstrate how they contribute to knowledge in these three areas. Moreover, we show how the afterword to the special issue widens the perspective on technology integration by taking into account systems and cultures of practice. Due to their quantitative empirical nature, the eight articles investigate technology at the current state of the art. However, the potential of artificial intelligence has not yet been fully exploited in education. We provide an outlook on potential developments and their implications on teachers' technology-related KSA. To this end, we introduce the concept of augmentation strategies."

Silva, J. B., Nardi Silva, I, & Bilessimo, S. (2020). Technological structure for technology integration in the classroom, inspired by the maker culture. *Journal of Information Technology Education: Research*, 19, 167-204. https://doi.org/10.28945/4532

Abstract: "This paper presented the framework for the integration of digital technologies in education, implemented in InTecEdu Program, developed by Remote Experimentation Laboratory (RExLab), Federal University of Santa Catarina (UFSC), Brazil. The main objective of the model presented is to arouse interest in science and technology among adolescents. Therefore, it sought to develop STEM competencies (Science, Technology, Engineering, and

Mathematics) in children and adolescents. Understanding learning in STAM areas can favor the development of professionals who can supply the demand in related sectors, especially in the scientific-technological scope. To fulfill the main objective, strategies related to students and teachers were developed. With activities aimed at students, it was hoped to promote vocations to scientific-technological careers and encourage entrepreneurship. On the other hand, the activities related to teachers aimed at training them to integrate technology into their lesson plans. Inspired by the Maker Culture, the model sought to make it possible for teachers to become the main agents in the process of integrating technology in their lesson plans, since they were in charge of building and producing their digital content and other resources to support their didactic activities. The maker movement is a technological extension of the "Do It Yourself!" culture, which encourages ordinary people to build, modify, repair and manufacture their objects, with their own hands. The training actions were preceded by a diagnosis, inspired by the Technological Pedagogical Content Knowledge (TPACK) model, as well as the lesson plans prepared and made available by the teachers. The results, about students, indicated an increase in motivation due to the creation of new teaching and learning opportunities. The fact of extending the classroom and school, through remote laboratories, to support practical activities and the use of VLE, was also pointed out as a very positive factor. On the other hand, the realization of the workshops, inspired by practices of the Maker Culture, provided an approximation of these to the skills of the real world, which will certainly favor their employability. Regarding the teachers, it is noticed the continuity and expansion in the use of technological re-sources in the classroom; many sought and have participated in new training actions"

Sitepu, S., Masela, M., & Kurniawati, L.A. (2020). Designing technology-assisted learning materials for ESP nursing students by using TPACK. *Interference Journal of Language Literature and Linguistics*, *1*(1).

Abstract: "The main purposes of this research is to design technology-assisted lesson materials for nursing students by using TPACK. English for Specific Purposes (henceforth, ESP) for nursing students focuses on preparing students to use English in their academic field and support their professions in their future career as a nurse. Conducted in one of private health science schools in Yogyakarta, this research employed Research and Development (henceforth, R&D) as the method. Needs analysis by using interviews and observations were done to gather the data. The research participants were one English teacher and 45 nursing students of the third semester of the respective institution. In addition to the research method, Analysis, Design, Development, Implementation, and Evaluation (henceforth, ADDIE) framework was adopted to design the lesson materials. The results of the research indicated that the students showed their needs and interests in using technological tools during their learning process; this was revealed through the results of the needs analysis conducted at the beginning of the research. Secondly, the technological tools implemented by using TPACK framework seem to empower the students during the learning process; they got more confident in engaging the classroom activities and participated more actively in class. The results of this research will provide insight for ESP teachers in designing technology assisted lesson materials and instructional activities by

using TPACK framework. Moreover, ESP teachers might consider to implement TPACK framework to build blended learning environment in facilitating student learning."

Smith, E. E., Kahlke, R., & Judd, T. (2020). Not just digital natives: Integrating technologies in professional education contexts. *Australasian Journal of Educational Technology*, *36*(3). https://doi.org/10.14742/ajet.5689

Abstract: "In 2001, Prensky characterised a new generation of learners entering higher education as *digital natives* – naturally digitally literate and inherently proficient users of technology. While many educational technology researchers have long argued for the need to move beyond the digital native assumptions proposed by Prensky and other futurists, a critical review of the literature reveals that this concept remains influential in academia broadly and within professional education specifically. In light of this, we propose an alternative approach to technology integration in professional education settings that aims to avoid unhelpful digital native stereotypes by instead developing digital literacies in ways that leverage technological affordances. By building digital literacies across the procedural and technical, cognitive, and sociocultural domains connected to professional competencies, learners can effectively adopt and utilise emerging technologies through professional digital practices."

Sojanah, J., Suwatno, S., Kodri, K., & Machmud, A.. (2021). Factors affecting teachers' technological pedagogical and content knowledge (A survey on economics teacher knowledge) . *Jurnal Cakrawala Pendidikan*, *40*(1), 1–16. https://doi.org/10.21831/cp.v40i1.31035

Abstract: "This study was conducted due to the lack of teachers' Technological Pedagogical and Content Knowledge (TPACK). It examined the effects of teaching experience, training, facilities and infrastructure, self-efficacy, as well as motivation on teachers' TPACK. The descriptive and explanatory methods with quantitative approaches were employed. The population of this study included 472 economics teachers in the Greater Bandung area, while the respondents were 217 economics teachers selected using the proportional probability sampling technique. The instrument used to collect the data was tried out to forty economics teachers. The instrument validity was measured using the CVR formula, and the instrument reliability was tested using construct reliability. The data were collected by means of questionnaires and then analyzed using descriptive analysis and Structural Equation Modeling (SEM). The results show that the teachers' experience, training, facilities and infrastructure, self-efficacy, as well as motivation are at a low level. Likewise, the teachers' TPACK seems to be low. Moreover, it is found that teaching experience, training, facilities and infrastructure, self-efficacy, as well as motivation have positive effects on teachers' TPACK."

Soler-Costa, R., Moreno-Guerrero, A.-J., López-Belmonte, J., & Marín-Marín, J.-A. Co-word analysis and academic performance of the term TPACK in Web of Science. *Sustainability 2021*, *13*, 1481. https://doi.org/10.3390/su13031481

Abstract: "The progress of technology has led to the emergence of new teaching methods, among which Technological Pedagogical Content Knowledge (TPACK) can be found in an attempt to promote the integration of technology and knowledge, combining technology, pedagogy and theoretical content. The aim of this research is to analyze the significance and evolution of the TPACK concept in the publications contained in Web of Science (WoS). The research method chosen is based on bibliometrics, specifically on the analysis of academic performance and on the analysis of co-words. The total number of documents analyzed is 471. The results show that research on TPACK is on the rise, increasing progressively in recent years. The main area of research is education and educational research, with articles, written in English, being the medium used by researchers to present their results. It can be concluded that, although there is an established research base, there is no single line of research. In this case, the main lines of research are "framework-framework-TPACK" and "technology-pedagogy-beliefs". It can be determined that the studies on TPACK deal with the integration of technological resources and the analysis of their perception in student learning."

Sumi, V. S., & Shaikh, S. A. (2021). Pedagogical use of ICT in science education in the light of techno pedagogical content knowledge (TPCK). *Online Journal of Distance Education and e-Learning*, *9*(1), 156-161.
http://www.tojdel.net/journals/tojdel/articles/v09i01/v09i01-16.pdf

Abstract: "To improve the opportunities for learning, a classroom is now turned into a well-resourced smart classroom. Integrating technology into teaching-learning maximize students' understanding of the related concepts and therefore makes it concrete. Researchers found that meaningful learning takes place where there is engagement from the part of students is more. ICT makes it possible for the students by giving those hands-on experiences through virtual reality, simulation, 3D experiences to support their learning. In this context, technology is much more important in Science Education, particularly in providing practical experiences. The core of good teaching with technology are three core components: content, pedagogy, and technology, and their relationships among and between them. This paper tries to explore how science teachers' understanding of educational technologies and Pedagogical Content Knowledge interact with one another to produce effective teaching with technology. This study adopts a descriptive survey method with a sample consists of 52 secondary school science teachers from Hyderabad. The random sampling method is used to collect the relevant sample. The questionnaire on TPCK based on understanding, integration, and assessment is used to collect the data required for the study. Percentage Analysis and Pearson's product-moment Correlation is the statistical technique used to analyze the data. The results of the study throw light on various technological, institutional, and professional factors that require attention. Findings of the current study indicated that teachers have very little knowledge about the various dimensions of TPCK. The study also throws light on the relation between teaching experience and technology integration. The results show that the more experienced teachers have a feeble connection with technology integration. Some suggestions to improve the practice is put forward in this paper."

Surayya, S. A., & Asrobi, M. (2020). Tracing technological pedagogical content knowledge (TPACK) on practical EFL teachers in writing context. *VOLES: Voices of English Language Education Society*, *4*(2), 177-190. http://dx.doi.org/10.29408/veles. v4i2.2417

Abstract: "With the world demand to provide digital school, this study examines how the integration among technology, pedagogy and content knowledge in writing context as the part of TPACK framework on the practical EFL teachers. The samples of this study are 27 of practical English teachers divided into three level of achiever (low, middle, and high). They were taking the Writing and Assessment courses as the part of their education to achieve the bachelor degree in Universitas Hamzanwadi, a private University in Lombok, Indonesia. This research took about six months of teaching and learning process. The observation and document results of the practical EFL teachers become the data primer of this study since the researchers act directly as the lecturer in the writing course. This study uses qualitative research as it investigates a process of teaching learning that lasted several months and happened in a particular setting. The result of study showed that the practical teachers" writing content and pedagogy knowledge were better than their technological knowledge. Furthermore, the high achievers of practical EFL teachers perform a good TPK and TCK rather than they who come from middle and low achiever."

Suters, l., & Suters, H. (2020). Coding for the core: Computational thinking and middle grades mathematics. *Contemporary Issues in Technology and Teacher Education*, *20*(3). https://citejournal.org/volume-20/issue-3-20/mathematics/coding-for-the-core-computational-thinking-and-middle-grades-mathematics

Abstract: "National standards and frameworks for mathematics, computer science, and technology emphasize the importance of teaching all children computational thinking (CT) skills. These skills are important for preparing citizens that are literate in science, technology, engineering, and mathematics and for participation in a society that is rapidly changing with emerging technologies. This paper describes a 72-hour summer institute for grades 6-8 middle school mathematics teachers (n = 22) with a comprehensive approach to professional development, including training in computer programming with Bootstrap Algebra and Lego® Mindstorms® robotics, mathematics content sessions, and mathematics pedagogy sessions. Results of an assessment used to measure content knowledge and CT skills as well as the Technological Pedagogical Content Knowledge survey yielded statistically significant increases. Participant reflections revealed they valued opportunities for collaboration within grade-level professional learning communities and integration of CT strategies through both programming and robotics. Based upon participant feedback we recommend choosing either the use of Bootstrap Algebra or Lego Mindstorms within shorter timeframes to better prepare teachers for classroom implementation. These middle school teachers were receptive to mathematics-specific content sessions focused on developing conceptual understanding of mathematics they teach as well as grade-level appropriate manipulatives."

Tachie, S. A. (2019). Challenges and opportunities regarding usage of computers in the teaching

and learning of mathematics. *South African Journal of Education, 39*(2), 1-10. https://doi.org/10.15700/saje.v39ns2a1690

Abstract: "Many studies have identified the fact that most mathematics teachers experience challenges in using technology in their teaching, and learners also find it difficult to use it in their learning. Teachers often fail to address opportunities regarding this usage to address the situation. This paper explores factors contributing to teachers' and learners' challenges and opportunities for using Information and Communication Technology (ICT), such as computers, in the teaching and learning of mathematics in the OR Tambo Education District. A case-study design was used. The sample comprised 5 teachers and 5 learners selected from 5 performing schools in the District. Individual interviews and open-ended questionnaires were used for data collection. Content analysis was used to analyse the data. The study revealed that a lack of computer tuition opportunities, school managers' attitudes and limited material resources contributed to challenges and opportunities regarding the use of computers in mathematics instruction in schools. The study concluded that a lack of teachers' access to the use of computers in schools made it difficult for them to assist learners in the use of computers for teaching and for school tasks. Recommendations have been made to help enforce and monitor the use of available computers in schools."

Tamulee, P. (2020). Pedagogic transformation: Comparing educational technology in the US and India. *World Journal of Educational Research and Reviews*, *6*(1), 104-111. https://premierpublishers.org/wjer/040720207220

Abstract: "In the last 15 years, the US and India have witnessed increasing bilateral cooperation on broad and multi-sectoral matters especially in the field of education and technology. This has led to enormous policy borrowing and practice sharing in educational technology from the US. Acknowledging the contemporary strategic ties between the countries, this paper compares the historic evolution of educational technology as pedagogic transformation within the K-12 classrooms to identify the critical factors contributing to the contemporary educational technology scenario in the respective countries. The TPACK framework of educational pedagogy is used to analyze and determine the evolutionary journeys of pedagogic transformation during the Digital Phases: the personal computer and the internet. While comparing the two countries, it is found that independent socio-cultural and political factors have influenced the specific trajectory. Thereby, making the scientific investigation of the 'contextual forces' affecting the pedagogic transformation of educational technology within both the home (the US) and the target (India) key to policy-makers."

Terra, I.W. A., Ridlo, Z. R., Indrawati, Hidayah, S. (2020). Differentiation between TPACK level in junior and senior pre-service teachers to design science lessons. *Journal of Physics: Conference Series*, *1563*(012061). https://doi.org/10.1088/1742-6596/1563/1/012061

Abstract: "Technological development provides enormous opportunities for efficient and active learning. Advance in technology-based learning should be inline with the ability of teachers to teach science using technology. Preservice teachers should be equipped with an appropriate

college curriculum. TPACK can be used to see the abilities of prospective science teachers. This study was examining different TPACK levels at junior and senior-level. This study involved a sample of students majoring in a bachelor's degree in science teacher program. The results of the questionnaire showed that junior-level students have higher TPACK than senior-level. Based on the results of a lesson plan analysis, junior-level students tend to use technology in the classroom. Students at the senior-level have been experienced in classroom teaching. However, classroom management and time management skills of maybe affects the TPACK level in junior and senior-level students."

Terzi, R., (2020). The impact of understanding learners and techno-pedagogical competency on effective learning environments by designing the instructional process. *Turkish Journal of Education*, *9*(3), 246-259. https://doi.org/10.19128/turje.746953

Abstract: "This study aims to understand prospective teachers' (PTs) preparedness to teach before they actually start working in the profession. In particular, the causal effects of "understanding the learner" and "techno-pedagogical competency" on "forming effective learning environments" by "designing the instructional process" were investigated. Structural equation modeling was carried out to estimate the effects of these variables on effective learning environments. A cross-sectional survey design was used with 314 PTs who were studying in a state university in Turkey in the 2019-2020 spring semester. For the purpose of this study, Preparedness to Teach scale was used to obtain the data after investigating the scale for validity and reliability properties. The results suggested that understanding the learner had both direct and indirect effects on forming effective learning environments. That is, the better PTs could understand the learner, the more appropriately they could design the instructional process and, ultimately, form an effective learning environment. However, techno-pedagogical competency had only indirect impacts on forming an effective learning environment. This finding suggests that the higher-competency PTs had in techno-pedagogy, the more effectively they could establish a learning environment by properly designing the instructional process.

Thohir, M. A., Jumadi, J. & Warsono, W. (2020) Technological pedagogical content knowledge (TPACK) of pre-service science teachers: A Delphi study. *Journal of Research on Technology in Education*. Advance online publication. https://doi.org/10.1080/15391523.2020.1814908

Abstract: "Technological Pedagogical Content Knowledge (TPACK) is an emerging competence of pre-service science teachers in the 21st education century. In Indonesian context, knowledge about the use of technology to develop teachers is way too limited. Therefore, this study aimed to identify pre-service teacher competencies in integrating technology into science instruction. To achieve a consensus of the identification, this study used 30 science experts in three rounds of Delphi method. Out of the 30, 19 participated in Round One, 17 in Two, and 15 in Three. The experts were asked to answer a set of questions in 2 questionnaires in round Two and Three with anonymous identity. The result showed that the experts' agreement promoted the four dimensions of TPACK (4 D-TPACK), which are knowledge, skill, character, and meta-learning. Moreover, most of them identified 26 important competencies which were further specified

into 14 items and classified into 4 dimensions. The general pedagogical and technological knowledge were rated with a high-level of competence. Therefore, the implication of these findings is that the institution of pre-service science teachers that integrates technology needs to involve 4 D-TPACK and adopt the significant item of competencies to enhance the program."

Tien, E. C., Tin, Y. C., & Hamid, H. (2020). Use of technology in active learning teaching practices to enhance lecturer's self-efficacy in technical university enrichment. *International Journal of Engineering Research & Technology*, *9*(6), 436–443.

Abstract: "Research has indicated that more schools have increased their efforts to transform traditional classrooms into innovative 21stcentury learning environments. Some schools have even gone as far as implementing one-to-one digital learning environments. However, technology integration in education has been a slow transformational process, and studies have demonstrated that there are numerous barriers educators encounter along the way. The purpose of this study was to examine the first-and second-order barriers to Educational and Communication Technologies (ECTs) teachers experience in a 1:1 middle school learning environment. The perspectives of middle school educators who participated in this research study were examined. The research questions were used to determine the presence of first-and second-order barriers and to what degree there was a relative difference regarding teacher demographics and first-and second-order barriers to ECTs in 1:1 digital environments. In this descriptive, comparative research design, quantitative data was collected through an online survey, Barriers to Technology Integration. The data were analyzed using descriptive statistics and MANOVA analysis. Through the analysis of data, it was determined that there were no statistically significant differences in teacher demographics (teacher age group, years of teaching experience, and level of education) relative to the first-and second-order barriers regarding 1:1 technology integration. The means from the descriptive statistics suggested a low to moderate presence of first-and second-order barriers. The findings of this research study not only support the literature on first and second-order barriers to technology integration but also support the need for more longitudinal studies in middle school research and technology integration."

Tosuntaş, Ş. B., Çubukçu, Z., & Beauchamp, G. (2021). Teacher performance in terms of technopedagogical content knowledge competencies. *Kastamonu Education Journal*, *29*(1), 63-83. https://dergipark.org.tr/tr/pub/kefdergi/issue/59781/726886

Abstract: "Purpose: Technology can be quickly and effectively integrated into education processes due to its rapidly developing and changing nature. Technopedagogical content knowledge (TPACK) emerges as one of the important types of knowledge that teachers should have in the process of technology integration. Teacher performance is naturally affected, as technology integration reshapes the education process. However, there are no studies on how teacher performance is related to the use of technology in Turkey, and teacher performance evaluation is not studied robustly. This study aims to determine the relationship between teachers' TPACK competencies and their performance.

Design/Methodology/Approach: This study was designed using a correlational model to determine the relationship between teachers' TPACK competencies and performance. The study group consists of 305 teachers working in primary, secondary and high schools in the Central Anatolia Region. Data in the study were collected through TPACK-Practical Scale and Teacher Performance Scale. The data were analyzed using descriptive statistics, t-test, ANOVA, correlation and regression techniques.

Findings: The findings of the study showed that TPACK and performance did not differ according to the gender of the teachers. TPACK competencies differ according to educational status and school type, and teacher performance differs according to school type. TPACK competencies and performances of teachers were negatively correlated with their ages and seniority. On the other hand, small positive relationships were determined between TPACK and performance.

Conclusions: As a result, thanks to technology integration, teacher performance can be improved, and student achievement, which is seen as the most concrete output of teacher performance, can be improved. In this respect, it can be suggested that TPACK is considered as a whole, and it can be developed theoretically and practically. This study suggests that technology, pedagogy, and content knowledge should not be included separately in teacher education, but presented in an integrated way."

Trevisan, O., & De Rossi, M. (2020). Student teachers' pedagogical reasoning in TPCK-based design tasks: A multiple case study. *Qwerty: Open and Interdisciplinary Journal of Technology, Culture, and Education*, *15*(2), 68-84. https://doi.org/10.30557/QW000031

Abstract: "Teachers' professional expertise cannot ignore anymore a technological component to it. Technology is nowadays accessible more and more widely, but it does not automatically translate into learning improvement. It is crucial to understand how educators give meaning to technology integration in their practices, i.e. investigate teachers' professional reasoning. The paper reports on part of a wider study on Initial Teacher Education (ITE) institutions' capability to engage student-teachers' reasoning. Within the broader multiple case study across Europe, the paper reports on data emerging from document analysis and focused interviews with pre-service teachers (N tot 36). The findings suggest an activation of reasoning whose roots might find place outside ITE influence, encouraging further research."

Tseng, J.-J., Chai, C. S., Tan, L. & Park, M. (2020) A critical review of research on technological pedagogical and content knowledge (TPACK) in language teaching. *Computer Assisted Language Learning*. Advance online publication. https://doi.org/10.1080/09588221.2020.1868531

Abstract: "Research on TPACK has been burgeoning recently. Some review studies in the field of educational technology have indicated issues and trends in TPACK research conducted in the past decades. However, a review of TPACK research specific to language teachers' knowledge about language teaching with technology has been lacking. To fill this research gap, the present review study intends to understand the landscape of TPACK research on language teachers published from 2011 to 2019. The analysis results reveal that 51 studies were identified with a

publication peak in 2015, mostly conducted in Asia and the Middle East. The 51 articles were categorized into four areas: (a) exploring TPACK, (b) assessing TPACK, (c) developing TPACK, and (d) applying TPACK. More specifically, research on exploring TPACK suggests that while teachers had varying levels of confidence in their TPACK competence, their TPACK indicated the dominant use of technology in traditional teacher-centered teaching. Research on assessing TPACK shows that survey items were contextualized to lessen the difficulty of distinguishing between the seven sub-domains of TPACK. However, the difficulty remained perhaps due to a possibility that the seven sub-domains may not appear workable in practice. This issue needs further research. Research on developing TPACK reveals that effective interventions involved language teachers' understanding of the TPACK framework, modeling from teacher educators or experienced teachers, and language teachers' engagement in designing lessons collaboratively. Finally, research on applying TPACK indicates that TPACK-informed language learning courses and platforms were perceived to be helpful and effective. These findings may provide researchers with some possible directions."

Tunjera, N., & Chigona, A. (2020). Teacher educators' appropriation of TPACK-SAMR models for 21st century pre-service teacher preparation. *International Journal of Information and Communication Technology Education, 16*(3), 126-140. https://doi.org/10.4018/ijicte.2020070110

Abstract: "The study examined how teacher educators are appropriating technological, pedagogical, and content knowledge (TPACK) and substitution, augmentation, modification, redefinition (SAMR) frameworks in their pre-service teacher preparation programmes. To ensure rigor, quality, and preparedness of pre-service teachers, there is a need to articulate expectations around effective use of these frameworks together with contemporary teaching and learning theories at the pre-service teacher preparation level. One-on-one in-depth interviews and participant observations were conducted with eight (8) teacher educators. The findings revealed that teacher educators are appropriating technology in ways harmonious with their prevalent traditional teacher-centred teaching strategies at enhancement levels. The researchers recommend the adoption of technology integration frameworks and teaching and learning theory at policy making levels in pre-service teacher training institutions."

Utami, R. A., & Muhtadi, A. (2019). TPACK-based E-book for learning chemistry in senior high school. *Advances in Social Science, Education and Humanities Research, 440*, 166-168. https://doi.org/10.2991/assehr.k.200521.036

Abstract: "Abstract chemistry learning requires the help of teaching material that can represent chemical material into concrete material in order to help students understand chemical material. Learning chemistry that is abstract and difficult to understand if only done with the lecture method will make it difficult for students to understand the learning material. The use of teaching materials and teacher's skills in teaching are essential things that can help students in overcoming difficulties faced in the chemistry learning process. This research was conducted as a foundation to describe the need for teaching materials that integrate TPACK in chemistry learning. The research method used in this study was a survey method; then, the researcher

was analyzing the data obtained descriptively. Samples were taken by purposive sampling at 35 students majoring in science in high school by using a questionnaire as a data collection instrument. The survey results found that in learning chemistry, 83.9% of students need a teaching material that integrates technology, pedagogy, and content knowledge (TPACK) to achieve optimal learning. For this reason, it is necessary to develop chemical teaching materials based on TPACK (Technological Pedagogical Content Knowledge)."

Valtonen, T., Hoang, N., Sointu, E., Näykki, P., Virtanen, A., Pöysä-Tarhonen, J., Häkkinen, P., Järvelä, S., Mäkitalo, K., & Kukkonen, J.. (2021). How pre-service teachers perceive their 21st-century skills and dispositions: A longitudinal perspective. *Computers in Human Behavior*, *116*, 106643. https://doi.org/10.1016/j.chb.2020.106643

Abstract: "Research-based discussions about 21st-century skills are currently needed; 21st-century skills refer to skills that today's students are expected to possess for successful future careers. The ways students perceive these skills or what kind of dispositions they have in this regard are significant. This paper provides an overview of the development of pre-service teachers' perceived 21st-century skills and dispositions. The quantitative data was collected in three phases during 2014, 2015, and 2016 at three Finnish universities. The number of respondents at each measurement point varied from 209 to 267. Data were analysed using latent growth curve modeling. The study focuses on students' perceptions of three areas related to 21st-century skills: learning skills, collaboration dispositions, and skills to use ICT. The results show that the three areas evolved in different ways. Learning skills and collaboration dispositions show up as yearly assessments that remain at the same level, with small differences among respondents, unlike skills to use ICT with bigger yearly changes. The measured areas also appear as separate entities throughout the bachelor's studies, with small or non-significant correlations. These results reveal important new perspectives on how pre-service teachers perceive 21st-century skills and how perceptions evolve during teacher education."

Valtonen, T., Leppänen, U., Hyppiä, M., Sointu, E., Smits, A., & Tondeur, J. (2020). Fresh perspectives on TPACK: Pre-service teachers' own appraisal of their challenging and confident TPACK areas. *Education & Information Technologies*, *25*(4), 2823–2842. https://doi.org/10.1007/s10639-019-10092-4

Abstract: "The present study is an extension of studies that measure pre-service teachers' Technological Pedagogical Content Knowledge (TPACK) confidence. It provides new perspectives on pre-service teachers' TPACK by shifting the focus to concrete concerns and strengths indicated by pre-service teachers. The target group consists of a cohort of first-year pre-service teachers (N = 86) from a Finnish university. The data used in this study were 86 lesson plans with integrated technology written by first-year pre-service teachers, with a specific section where students outlined their confident and challenging areas in the lesson plan. These sections were analyzed quantitatively through the theoretical lens of TPACK. Four TPACK areas were found confident, challenging or both confident and challenging for students. For these first-year pre-service teachers, pedagogical knowledge played the most important role, and the outcomes concretize specific aspects of pedagogical knowledge that can be

addressed to develop TPACK in teacher education. The results provide important perspectives on pre-service-teachers' development of TPACK, revealing the important position of pedagogical knowledge and detailed perspectives on how pre-service teachers view their readiness to use ICT in education."

Viera, R. T., & Sanchez, D. I. V. (2020). Research on technology competencies in EFL language instructors: Technology-pedagogy-content in language teaching. *Script Journal: Journal of Linguistics and English Teaching*, *5*(1), 33-43. https://doi.org/10.24903/sj.v5i1.414

Abstract: "Background: Living in the digital era where the information and communication technologies (ICTs) have extensively changed the way of teaching, language instructors, in particular, should be computer literate to put their technical knowledge into practice in such a way they effectively integrate technology into language learning classrooms.

Methodology: The research contextualizes teachers' beliefs and competencies of using the Technological Pedagogical Content Knowledge (TPCK) in teaching English as a foreign language. The study is an extension of previous research carried out by Tovar et at., (2019), and Tovar (2019). It applied a survey-based questionnaire, an unstructured interview, and classroom observations for data collection. The assessment instruments were administrated to EFL language instructors, who work in the Language Center at the Technical University of Cotopaxi.

Findings: Results revealed that a high percentage of the EFL language instructors are not familiar with the use of the TPCK model and its integration into their classroom practices. This support the claim that teachers probably have technological knowledge, but they are not well-prepared to combine teaching resources and appropriate pedagogical methods for language teaching and learning.

Conclusions: The study hopes that research outcomes arise linguistic implications and pedagogical applications for developing teachers' TPCK competencies when integrating technology in EFL classroom settings. Limitations, as well as considerations for further research, are discussed."

Wagiran, Retnowati, E., & Azman, M. N., A. (2020). When vocational teachers improve their TPACK competencies through lesson study. *International Journal of Psychosocial Rehabilitation*, *24*(4), 2469-2479. https://doi.org/10.37200/IJPR/V24I4/PR201354

Abstract: "Teachers at vocational schools may be more challenged than at public high schools since they aim to teach working skills that could be more complex than just knowledge. The paper aims to propose models of lesson study for vocational teachers. It is proposed that when vocational teachers utilize lesson study to improve pedagogic competencies, a strategy to implement it is required to minimize possible obstacles. Further, through a systematic review, the perspective of Technical Pedagogical and Content Knowledge (TPCK) is used to develop the model of the teacher professionalism. A lesson study strategy is chosen depending on the focus of the professionalism by identifying pedagogic and content competencies level of the involving

teachers. Four types of teachers based on these dichotomies were developed, and therefore four models of lesson study could be derived. The models offer what specific competence to learn during the lesson study. Through the use of the lesson study model, vocational teachers in across different fields could decide the most relevant model of their professionalism, with regard to their competence in pedagogic, content, or technological knowledge. Eventually, the lesson study model becomes a strategic pathway to solve issues in vocational education. Improvement of the effectiveness lesson study practice when suitable model is applied can be achieved. This paper offers lesson study models that are developed based on teacher typology of competence, particularly for vocational teachers with wide-range of specialities."

Walan, S. (2020). Embracing digital technology in science classrooms- secondary school teachers' enacted teaching and reflections on practice. *Journal of Science Education and Technology*, *29*, 431-441. https://doi.org/10.1007/s10956-020-09828-6

Abstract: "The aim of this case study was to investigate what happens in science classrooms when teaching is almost entirely based on the use of digital technology. Two secondary school science teachers participated, together with their seventh grade classes. Data were collected through eight observation sessions (altogether about 9.5 h) and 9 h of interviews with the teachers. For analysis, a modified version of the Technological Pedagogical and Content Knowledge framework was used. The results showed the science teachers' general approach in the classroom and revealed that they were self-confident in using digital technology, and utilised predetermined digital study material and, when it was felt necessary, supplemental materials. The teachers were positive about using digital technology since they thought it motivated their students and made assessment easier. The teachers claimed that digital technology had improved their teaching, providing more breadth because of access to varied digital tools; teaching had also become more individualised. Few differences were identified between different lessons, whether in physics, chemistry or biology, and unfortunately the identified relationship between the use of digital technology and content knowledge was limited. The teachers also reflected on the challenges they faced, especially in supporting low-achieving students and effectively using inquiry-based teaching through digital technology. Despite some acknowledged limitations, the study enhances our knowledge about how the Technological Pedagogical Content Knowledge framework can be used as an analytical tool in authentic teaching, with specific contexts and, above all, when education is largely based on the comprehensive use of digital technology rather than its occasional integration."

Wekerle, C., Daumiller, M., & Kollar, I. (2020). Using digital technology to promote higher education learning: The importance of different learning activities and their relations to learning outcomes, *Journal of Research on Technology in Education*. Advance online publication. https://doi.org/10.1080/15391523.2020.179

Abstract: "Digital technologies can have positive effects on student learning in higher education. Based on the ICAP framework, they should be particularly effective when teachers use them to encourage student engagement in constructive and interactive as opposed to passive and active learning activities. Using a sample of 381 higher education students, we

investigated if student engagement in these activities depends on whether technologies are implemented in class or not, and how engagement in these activities affects learning outcomes. Results indicated that when technologies were implemented in class, students felt encouraged to engage in more constructive, but also in more passive and active activities as com-pared to when no technologies were used. Furthermore, student engagement in active, constructive, and interactive activities was positively associated with learning outcomes."

Wekerle, C., & Kollar, I. (2021). Fostering pre-service teachers' situation-specific technological pedagogical knowledge – Does learning by mapping and learning from worked examples help?. *Computers in Human Behavior, 115, 1*06617. https://doi.org/10.1016/j.chb.2020.106617

Abstract: "In order to exploit the potentials of digital technology in classrooms, it is necessary to enhance future teachers' situation-specific Techno-logical Pedagogical Knowledge (TPK) as manifested in their professional vision (i.e., their noticing and knowledge-based reasoning of technology-enhanced classroom situations). To this end, we differentiate between formal quality (whether pre-service teachers display reasoning steps related to professional vision) and content quality (whether pre-service teachers make adequate use of scientific knowledge) of pre-service teachers' reasoning about technology-enhanced teaching. Based on empirical findings, we hypothesized that learning by mapping would facilitate the content quality and learning from worked examples would enhance both formal and content quality of pre- service teachers' TPK-related professional vision. We tested these hypotheses with a sample of 252 pre-service teachers who first either read or mapped scientific texts and then either analyzed authentic technology-enhanced classroom cases or received worked examples on how to do so. Results from structural equation modeling demonstrated a positive association of learning with worked examples and content quality, but no relation to formal quality. Learning by mapping even showed rather negative associations with content quality. However, the quality of maps partly functioned as a significant predictor. Possible reasons and consequences are discussed."

Wen, H., & Shinas, V. H. (2020) Using a multidimensional approach to examine TPACK among teacher candidates, *Journal of Digital Learning in Teacher Education*, *37*(1), 30-47. https://doi.org/10.1080/21532974.2020.1804493

Abstract: "The Technological Pedagogical and Content Knowledge (TPACK) conceptual framework captures the complex nature of teacher knowledge essential for effective teaching in the digital age. TPACK is difficult to assess, however, particularly among teacher candidates whose pedagogical knowledge is developing. This study aimed to examine multiple ways to assess teacher candidates' TPACK development and its application in response to a technology-focused coursework. Using a mixed-method, multi-assessment design, the study sampled 26 teacher candidates enrolled in a graduate-level course. TPACK survey at two time points and multiple course artifacts including course reflection, lesson delivery reflection and unit plan design were used for analysis. Quantitative survey data pointed to the significant growth in all domains of TPACK except for PK. Qualitative reflection data revealed themes supporting the growth in key TPACK domains. However, unit plan analysis revealed some inconsistency with

the self-reported survey results, showing the limitation of TPACK survey. Unit plan data revealed variability and limited application of TPACK knowledge among teacher candidates who reported biggest TPACK growth, suggesting the necessity for providing more opportunities for acquiring TPACK in meaningful application. The study extends earlier research findings about the necessity of using multiple sources of information to assess teacher candidates' TPACK development."

Wilson, M. L., Ritzhaupt, A. D. & Cheng, L. (2020). The impact of teacher education courses for technology integration on pre-service teacher knowledge: A meta-analysis study. *Computers & Education*, *156.* https://doi.org/10.1016/j.compedu.2020.103941

Abstract: "The purpose of this study was to examine the effects of teacher education courses for technology integration (TECTI) on pre-service teacher *knowledge*. *Knowledge* is both the practical and conceptual knowledge that goes into technology integrated teaching and learning in PK12 classrooms. Subgroup analyses were executed to examine literature-based course design features (e.g., lesson planning) for TECTI and study features (e.g., measurement validity) hypothesized to moderate the effects. Following a carefully designed search strategy and coding process, this study narrowed down N = 2936 studies from five academic databases to a final set of n = 38 studies with k = 46 independent effect sizes. This meta-analysis captured the data from 3271 pre-service teachers with a statistically significant, positive effect size on knowledge at 1.057 (C.I. 0.836, 1.278) using a random-effects model. None of the course design features nor the study quality features were statistically significant. No evidence of publication bias was detected. A full discussion with limitations and future research is provided."

Wilujeng, I., Tadeko, N., Dwandaru, W. S. B. (2020). Website-based technological pedagogical and content knowledge for learning preparation of science teachers. *Cakrawala Pendidikan*, *39*(3), 545-559. https://doi.org/10.21831/cp.v39i3.31228

Abstract: "This study produces technological pedagogical and content knowledge (TPACK) instruments, which conventionally use print modules. The aims of this study were 1) to develop appropriate website-based TPACK instruments, and 2) to determine the effect of the produced website-based TPACK instruments toward the pedagogy competence of Science teachers in their learning preparation in the classroom. The methodology used was based on the ADDIE stages which stand for analyze, design, develop, implement, and evaluate. The results of this study include 1) instructions for producing TPACK instruments based on the results of synthesis; 2) instructions for making a website format based on the synthesis results; 3) TPACK framework design in website content; 4) TPACK instruments validation results; and 5) website validation results. Moreover, limited and field tests were conducted upon the website-based TPACK instruments to determine their effect toward the pedagogy competence of Science teachers. Quantitatively, the TPACK instruments scored 70 out of 76, while the website scored 60 out of 90. Finally, the limited and field tests results showed that website-based TPACK instruments positively affect the pedagogy competence of Science teachers in their learning preparation in the classroom with an overall Good category and a Very Good category for the usage evaluation from the users."

Xiong, X. B., Sing, C. C., Tsai, C.-C., & Liang, J.-C. (2020). Exploring the relationship between Chinese pre-service teachers' epistemic beliefs and their perceptions of technological pedagogical content knowledge (TPACK). *Educational Studies*. Advance online publication. https://doi.org/10.1080/03055698.2020.1814698

Abstract: "This study aimed to investigate the differences between pre-service teachers' (PSTs) perceived TPACK given the different clusters of their epistemic beliefs collected via a questionnaire. The responses gathered from 807 Chinese PSTs were utilised to elicit such a relationship. All of the participants responded to the Pre-service Teachers' Epistemic Belief (PTEB) survey and the Technology, Pedagogy and Content Knowledge (TPACK) survey. The results of the cluster analysis revealed that the PSTs were characterised into three clusters according to their responses to the PTEB, labelled as the Positivist, Partial Constructivist and Constructivist clusters. The ANOVA revealed that the pre-service teachers in both the Positivist and Partial Constructivist clusters had stronger perceptions of their TPACK than did the Constructivist PSTs. The results imply that more nuanced approaches are needed to develop PSTs' TPACK with reference to their epistemic profiles. In addition, it seems that the epistemic nature of creating TPACK may need to be discussed explicitly to foster PSTs' epistemic developments."

Xue, C., & He, W.. (2021). Research hotspots and trends on TPACK in WOS based on visual analysis. *Open Journal of Social Sciences*, *09*(02), 305–321. https://doi.org/10.4236/jss.2021.92021

Abstract: "This study adopted the bibliometric method to visually analyze 844 articles of TPACK from 2009 to 2020 in core collection database of Web of Science (WOS). The Visual analysis is conducted on the authors, research organizations, articles and keywords using CiteSpace to explore research hotspots and trends in research of TPACK in WOS. This paper reveals the most influential authors and institutions, highly cited articles, research hotspots and trends of TPACK research. The findings show that the research on TPACK has been moving forward and making significant development. The core author Ching Sing Chai of Nanyang Technological University is a typical representative, having published lots of influential articles. Nanyang Technological University is also the most influential institution. We can see that not only TPACK and PCK are the hotspots of research, but also "digital competence", "educational technology" and "learning by design" are hot research topics. "Learning activity," "professional knowledge," "pedagogical model," "teaching materials" are all the research trends of TPACK. Researchers are likely to integrate TPACK with more disciplines to enhance the applicability of TPACK and enlarge the research scope of TPACK in the future."

Yang, T., & Gunn, C. (2020). Understanding kindergarten teachers' perceptions of the use of touchscreen technologies: An exploratory study in mainland China. *E-Learning and Digital Media*. Advance online publication. https://doi.org/10.1177/2042753020980120

Abstract: "Touchscreen technologies have become an important part of many young children's lives. While kindergarten teachers' perceptions of the use of touchscreen devices have been investigated across many countries, empirical research on the topic remains scant in mainland China. In an exploratory study, the lead researcher interviewed six teachers from an exemplary kindergarten in Nanjing and analyzed relevant documents to further explore the teachers' beliefs around children's use of touchscreen technologies. The Technological Pedagogical and Content Knowledge (TPACK) model was used to understand the rationale behind teachers' perceptions and self-reported practices. Findings showed that participants generally perceived touchscreen devices as useful tools for catering to children's interests, believing they could provide active learning experiences. Teachers made decisions about children's use of touchscreen technologies based on their understandings of learning, pedagogy, subject content, and the affordances of these technologies. Implications for future research on kindergarten teachers' use of touchscreen technologies are also presented."

Yani, A., Ruhimat, M., & Mulyadi, A. (2021). The effect of TPACK framework on inquiry process: A study of geographic subject. *IOP Conference Series: Earth and Environmental Science*, *683*(2021), 012027. https://iopscience.iop.org/article/10.1088/1755-1315/683/1/012027/meta

Abstract: "The inquiry process constitutes one of the essential process in the learning process. Learners gain knowledge through the inquiry process to build knowledge of the information received. Teachers remains searching for the most effective learning strategy, so that students are motivated for the inquiry process. This study discusses the use the Technological Pedagogical Content Knowledge (TPACK) in the Geography learning process in high schools. The method is a quasi-experiment in the Geography learning process which was designed based on the TPACK framework to determine its effect on the inquiry process of students. The result shows that Geography learning process using TPACK framework affects the inquiry process as seen by the quality of questions raised by students. Based on the result, it can be concluded that student-involved learning process provides many opportunities for students to conduct inquiry process."

Yanış, H., & Yürük, N.(2020): Development, validity, and reliability of an educational robotics based technological pedagogical content knowledge self-efficacy scale. *Journal of Research on Technology in Education*. Advance online publication. https://doi.org/10.1080/15391523.2020.1784065

Abstract: "The integration of technology into science teaching by pre-service science teachers and their self-efficacy in using technology in their teaching practices are important issues for science education. The purpose of this study is to develop an Educational Robotics Technological Pedagogical Content Knowledge (ER-TPACK) self-efficacy scale based on a transformative TPACK framework. The data obtained from 266 pre-service science teachers were divided into two groups as 133 participants for generating exploratory factor analysis (EFA) and 133 participants for generating confirmatory factor analysis. Results of the EFA indicated that the ER-TPACK self-efficacy scale including 33 items loaded on a single factor.

Cronbach's alpha coefficient for sample 1 and sample 2 was 0.98. The findings revealed that the scale was a valid and reliable instrument for measuring pre-service science teachers' ER-TPACK self-efficacy.

Yun, E. (2020). Review of trends in physics education research using topic modeling. *Journal of Baltic Science Education*, *19*(3), 388–400. https://doi.org/10.33225/jbse/20.19.388

Abstract: "For both physicists who teach students in university and physics educators, how physics should be taught is a vital question. This study reviewed the trends of research in the field of physics education to identify the status of physics education research and help researchers in future studies. 2,959 articles were collected from the American Journal of Physics (AJP) and 745 articles from the Physics Review Physics Education Research (PRPER). Abstracts of the collected articles were used for the study. After preprocessing the texts of the abstracts, topics were extracted from the texts using topic modeling. The Late Dirichlet Allocation (LDA) model of Mallet was used for topic modeling. A total of 13 topics were extracted from the two journals. In re-cent years, "pedagogical content of knowledge (PCK)," "assessment" of achievement and "gender" of student have been topics of increasing interest; "teacher education" and "students' reasoning process" have been topics with continuous high interest, and "introductory physics" and "problem solving" in physics have been topics with decreasing interest."

Za'ba, N., Ismail, Z., & Abdullah, A. H. (2020). Preparing student teachers to teach mathematics with GeoGebra. Universal Journal of Educational Research 8(5A), 29-33. https://doi.org/10.13189/ujer.2020.081904

Abstract: "This paper shares the working process that has been carried out in a postgraduate mathematics teacher education course known as Technology in Mathematics Education. Many efforts around the world attempt to train student teachers on the use of technology without giving much attention to appropriate instructional model. Our work in this area gave special considerations in integrating technological pedagogical and content knowledge (TPACK) in training student teachers to teach mathematics with Geogebra, a dynamic multi-purpose mathematics software. Specifically, this paper shares the (1) theoretical background that guides the structure of the course, (2) the course methodology, which includes teaching and learning activities to prepare 15 student teachers to teach mathematics with GeoGebra and (3) the learning outcomes of the 14 weeks course. The design for integrating teachers' knowledge of subject matter, and teaching with subject matter with the development of TPACK was discussed. Among the GeoGebra activities emphasized are (1) creating geometric constructions and exploring their mathematical properties (2) exploring ratio and proportions, (3) applying sliders to modify parameters, (4) visualizing algebraic input and functions, and (5) modelling and constructing transformations in geometric designs and animations. Elements of TPACK were traced as the student teachers carried out experimental teaching with GeoGebra in schools as part of the requirement of the course. The Malaysian mathematics curriculum in its latest development has incorporate GeoGebra activities in the textbooks. Hopefully with the

course we described in this paper, not only more teachers are willing to adopt GeoGebra but to integrate GeoGebra effectively in their practices."

Zhang, H., Yu, L., Cui, Y., Ji, M., & Wang, Y. (2020). Mining classroom observation data for understanding teachers' teaching modes. *Interactive Learning Environments.* Advance online publication. https://doi.org/10.1080/10494820.2020.1734029

Abstract: "The study of teacher development and teaching interaction in physical classrooms has presented research problems, but with the development of classroom observation and video analysis, quantitative and visual analysis of the teaching process has been realized. In order to better understand the teaching models of teachers, this study is devoted to mining classroom observation data. First, based on content analysis, a Dynamic Network Analysis of Classroom Teaching Elements (CTE-DNA) framework has been developed in which classroom observation data are divided into three dimensions, teaching behavior, instructional media, and technological pedagogical content knowledge (TPACK). Second, using the method of social network analysis, teacher's teaching models are analyzed by measuring adjacency matrix and relative centrality. Last, key nodes of the network as well as teaching models are visualized. Based on CTE-DNA, classroom observation data can be used for evaluating teacher's teaching behaviors and performance, and can be beneficial to teacher's professional development."

Chapters

Avgerinou, M. D., & Moros, S. E. (2020). The 5-phase process as a balancing act during times of disruption: Transitioning to virtual teaching at an international JK-5 school. In R. E. Ferdig, E. Baumgartner, R. Hartshore, R. Kaplan-Rakowski, & C. Mouza (Eds.), *Teaching, technology and teacher education during the COVID-19 pandemic: Stories from the field* (pp. 583-594). Association for the Advancement of Computing in Education. https://www.learntechlib.org/p/216903/

Abstract: "Redesigning a drastically new approach for teaching and learning within grades JK-5 required immediate attention to all constituents' needs, including students, faculty, and parents, in order to maintain educational continuity in a functional and safe online learning environment. This work describes the 5-Phase Process designed as an action research-based, disruptive intervention to transition from the traditional, four-walled classroom into a virtual classroom, thus transforming learning experiences, routines, and perspectives in the Elementary School at the American Community Schools (ACS) Athens, Greece. This emergency shift occurred simultaneously with the professional development needs of in-service teachers, and was guided by research-informed best practices of virtual teaching, and effects of online learning for students between ages of 3-11, while bearing the state of emotional and financial stress of all constituents. While the 5-Phase Process is still in effect, preliminary results are shared, while implications for practice and recommendations for further research are considered."

Chan, K. K. (2021). Fostering future teachers' competence in computational thinking in an educational technology course. In S. Papadakis & M. Kalogiannakis, (Eds.), *Handbook of research on using educational robotics to facilitate student learning* (pp. 257-273). IGI Global. http://doi:10.4018/978-1-7998-6717-3.ch010

Abstract: "Computational thinking is considered a necessary skill in the 21st century. However, few teacher-education programs offer training for pre-service teachers to learn how to integrate computational thinking into the classroom. Pre-service teachers need to gain the knowledge and experience of computational thinking so that they are confident about designing relevant instructions in the future. The purpose of this chapter is to show how a free elective course in the teacher education program provides learning opportunities for them to develop their computational thinking skills and knowledge through the use of tangible objects. Samples of their works were analysed at different stages of learning to illustrate the technological pedagogical content knowledge of computational thinking. Overall, the study demonstrates that pre-service teachers were able to develop knowledge and attitudes towards computational thinking with their experience in the teacher education course. "

Chatterjee, S., & Parra, J. (2020). Innovative design revisions on an undergraduate technology integration course for K-12 preservice teachers. In R. E. Ferdig, E. Baumgartner, R. Hartshore, R. Kaplan-Rakowski, & C. Mouza (Eds.), *Teaching, technology and teacher education during the COVID-19 pandemic: Stories from the field* (pp. 431-442). Association for the Advancement of Computing in Education. https://www.learntechlib.org/p/216903/

Abstract: "This chapter discusses the innovative design revisions on an undergraduate technology integration course in the College of Education's teacher preparation program at a Southwestern University in the US. Due to COVID-19 pandemic, specific issues emerged-1) the course was taught for seven weeks instead of eight, and 2) with students experiencing a shift to all online learning, it was anticipated that students, who are mostly preservice teachers, would experience potential stresses that could impact student participation and success. Revisions were made related to technology tool use, modular design and streamlining of activities. Further, the course design and content incorporates Technological, Pedagogical, and Content Knowledge (TPACK) Framework. In the first iterations of this course, TPACK was an awareness topic while in this iteration, it was incorporated as a primary topic. In addition, implications of the revisions include the importance of student-centered course design and use of social media platforms for learning."

Chrysostomou, S., & Triantafyllaki, A. (2020). Transitioning to online music teacher education: Challenges and opportunities for knowledge development. In R. E. Ferdig, E. Baumgartner, R. Hartshore, R. Kaplan-Rakowski, & C. Mouza (Eds.), *Teaching, technology and teacher education during the COVID-19 pandemic: Stories from the field* (pp. 443-447). Association for the Advancement of Computing in Education. https://www.learntechlib.org/p/216903/

Abstract: "The context of this article is a non-compulsory pre-service teacher education program, fully incorporated within a five-year Bachelor of Arts Music degree in Athens, Greece. On March 11th 2020, when schools closed, the majority of our forty-three students on the program had completed less than half of the requirements of the thirty-hour teaching placement. A series of steps ensued that included mapping students' progress to-date, strengthening our collaboration with our team of teacher-mentors that continued to teach online, finding online alternatives for observing teaching, creating new teaching material to encourage students to re-imagine music teaching and learning online and, inevitably, shifting assessment requirements to accommodate the novel circumstances. While still at the beginning of our journey, this online transition for the teaching placement has presented both opportunities and challenges for developing new and desired forms of teacher knowledge."

Ervin-Kassab, L. (2020). Playing with faculty: Creating a learning management "sandbox." In R. E. Ferdig, E. Baumgartner, R. Hartshore, R. Kaplan-Rakowski, & C. Mouza (Eds.), *Teaching, technology and teacher education during the COVID-19 pandemic: Stories from the field* (pp. 17-22). Association for the Advancement of Computing in Education. https://www.learntechlib.org/p/216903/

Abstract: "This chapter describes how a college of education in the western United States created a learning management system "sandbox" space to host a community of practice for field supervisor and foundations faculty transitioning from face-to-face to online teaching. Technological pedagogical content knowledge and identity/efficacy professional contexts of faculty were key considerations in the design of the (a)synchronous space. A series of synchronous "playdates" were held to provide collaborative learning, practicing, and sharing practices do develop faculty skills in modeling educational technologies. Initial results indicate that field supervisors with low levels of technological confidence were the most consistent participants. Design elements of the sandbox and playdates, as well as recommendations for replication will be presented in this chapter."

Figg, C., & Jaipal-Jamani, K. (2020). Technology Teacher Educators: The role of self-study in supporting digital age technology teacher education. In A. R. Crowe (Ed.), *International handbook of self-study of teaching and teacher education practices* (2nd ed., pp. 985-1019). Springer, Singapore. https://doi.org/10.1007/978-981-13-6880-6_33

Abstract: "Technology teacher educators – those teacher educators who teach courses in teacher education programs focused on the pedagogy of how to teach with technology – are a small community, with a teacher education program counting itself privileged if they have one technology teacher educator on faculty offering stand-alone technology pedagogy courses. However, technology teacher educators have knowledge that is essential for shaping the digital landscape and promoting technology-enhanced teaching in both preservice teachers and fellow teacher educators. The purpose of this chapter is to provide a description of how research, specifically self-study research, informs our current understanding of the problems of practice of technology teacher educators. As well, it is within the scope of this chapter to identify any gaps in self-study research that could contribute to our understanding of how technology

teacher educators not only promote the knowledge about how to teach with technology but illuminate those problems of practice for technology teacher educators that are distinctly different from the examples in the self-study literature of how teacher educators build their own knowledge about how to teach with technology. Therefore, the chapter will present a review of the literature that describes best practices for building knowledge for teaching with technology appropriate for preservice teaching and illuminates the problems of practice experienced by technology teacher educators, with examples of teacher educators and their experiences. New directions for self-study research to support technology teacher educators so their stories are shared are also discussed."

Heath, M. K., & Segal, P. (2020). The trap of technocentrism: (Re)centering pedagogy for emergency remote teaching. In R. E. Ferdig, E. Baumgartner, R. Hartshore, R. Kaplan-Rakowski, & C. Mouza (Eds.), *Teaching, technology and teacher education during the COVID-19 pandemic: Stories from the field* (pp. 827-830). Association for the Advancement of Computing in Education. https://www.learntechlib.org/p/216903/

Abstract: "We prepared interns for technology integration in face-to-face environments; however, they struggled with the shift to emergency remote learning. Early analysis of observations and interviews indicate that when faced with the overwhelming technological imperatives of online teaching, teacher candidates fell into the trap of technocentrism. Even teacher candidates who effectively integrated technology in face-to-face classrooms had difficulty translating that skill to online teaching. In response, we (re)centered pedagogical and content knowledge in our preparation courses and developed resources for online pedagogies, instead of a database of online tools."

Hu, C. (2012). Creating an environment for pre-service teachers to develop technical pedagogical and content knowledge. In T. Lê & Q. Lê (Eds.), *Technologies for enhancing pedagogy, engagement and empowerment in education: Creating learning-friendly environments* (pp. 115-128). IGI Global. http://doi:10.4018/978-1-61350-074-3.ch010

Abstract: "This chapter reports a teacher education program in applying the framework of TPACK to the design of its ICT curriculum: the design principles employed, its implementation and a formative evaluation. A survey adapted from Schmidt et al. (2009) was administered at the beginning and completion of the course. The post-course survey showed an increase in pre-service teachers' self-reported ratings in all three types of knowledge, namely technological knowledge, technological pedagogical knowledge, and technology, pedagogy and content knowledge. Although majority (53.1%) of the pre-service teachers favored the approach of learning technology through engaging in design projects, many suggested that more structured instruction would benefit their learning."

Hulon, S. I., Tucker, M. H., & Green, A. M. (2020). Virtual professional learning for in-service teachers to support teaching and learning in online environments. In R. E. Ferdig, E. Baumgartner, R. Hartshore, R. Kaplan-Rakowski, & C. Mouza (Eds*.), Teaching, technology and teacher education during the COVID-19 pandemic: Stories from the field*

(pp. 43-46). Association for the Advancement of Computing in Education. https://www.learntechlib.org/p/216903/

Abstract: "The South Alabama Research and In-service Center (SARIC) is one of eleven regional in-service center in Alabama. SARIC works in partnership with the University of South Alabama College of Education and Professional Studies (USA CEPS) and the Alabama State Department of Education to meet the professional learning needs of ten public school districts in the southern region of the state. In response to COVID-19, public schools in Alabama closed the physical buildings; however, instruction continued in a variety of digital formats. As a support to educators within those districts, SARIC collaborated with the faculty in the University of South Alabama CEPS and experts in the school districts. SARIC offered virtual professional learning sessions for P-12 educators. The virtual sessions were essential for many educators, and continuous supports are needed for teachers in the area of instructional design."

James, C. C., & Lee, K. W. (2020). Mobilisation and enactment of Malaysian ESL teachers' technological pedagogical content knowledge: From professional learning to professional practice. In B. Zou & M. Thomas (Eds.), *Recent developments in technology-enhanced and computer-assisted language learning* (pp. 279–315). IGI Global. https://doi.org/10.4018/978-1-7998-1282-1.ch013

Abstract: "This chapter is a review of a three-year journey into exploring the development, mobilisation, and enactment of Malaysian ESL teachers' technological pedagogical content knowledge through a professional learning community known as 'Going Digital'. The first part of the chapter summarises the investigation on the effectiveness of the TPACK-IDDIRR + PLC as a transformative model of professional development to engender technology integration practices in the classroom. The findings reveal that the model is effective in enhancing technology integration practices of ESL teachers. In the second part, individual experiences of four members of the 'Going Digital' are narratively explored to understand the mobilisation and enactment of TPACK from professional development to practice in the classroom. The affordances and constraints of technology integration is explored in the third part. The chapter concludes with discussions on the interconnectedness of knowledge, context, and identity; and how it has led to the proposition of the model for TPACK mobilisation, appropriation, and enactment."

Jin, Y., & Redish, T. (2020). Professional development for remote learning in teacher education to support teacher educators and preservice teachers during the COVID-19 pandemic. In R. E. Ferdig, E. Baumgartner, R. Hartshore, R. Kaplan-Rakowski, & C. Mouza (Eds.), *Teaching, technology and teacher education during the COVID-19 pandemic: Stories from the field* (pp. 483-487). Association for the Advancement of Computing in Education. https://www.learntechlib.org/p/216903/

Abstract: "Teacher educators, preservice candidates, and in-service teachers are greatly challenged by the COVID-19 pandemic. Since March 2020, teacher educators have been engaged in serious heavy lifting to minimize the impact of school closures, canceled student

teaching, and postponed teaching abroad programs. They have spent hours moving instruction online and supporting the educational and emotional needs of their students. Best practices that ensure a smooth transition to remote learning, engage preservice teachers in online learning, and provide professional learning opportunities to teacher educators emerged organically during this process. The collective efforts are worthy of documenting and have been highlighted in this paper. Professional development strategies used to facilitate the transition and sustainability of remote learning in our teacher education program are discussed."

Kannan, J., & Munday, P. (2020). Challenges in using cloud technology for promoting learner autonomy in a spanish language course: reshaping pedagogical design. In Management Association, I. (Ed.), *Language learning and literacy: Breakthroughs in research and practice* (pp. 833-862). IGI Global. https://doi.org/10.4018/978-1-5225-9618-9.ch043

Abstract: "In a digitally networked classroom, the learner connects with peers, instructors, and open resources, be they human experts or online resources in non-linear combinations. As a result, the learner must navigate a complex web of associations and pathways. Thus the teacher practitioner who uses the networked medium as the platform for facilitating language learning has the challenge of developing methodologies, task-based activities, and a selection of tools to frame a learning ground that will provide maximum opportunity for the student to strengthen learning. This chapter will present a case study of a teacher practitioner's pedagogical design process in an online undergraduate course, "Advanced Grammar and Culture through Social Media." The main focus of this case study is to identify key challenges for pedagogical design and offer the rhizomatic approach as a model to promote learner autonomy."

Kingsley, K., & Ramsey, Z. (2020). Innovative online instruction: Synthesizing learning and video game consoles. In R. E. Ferdig, E. Baumgartner, R. Hartshore, R. Kaplan-Rakowski, & C. Mouza (Eds.), *Teaching, technology and teacher education during the COVID-19 pandemic: Stories from the field* (pp. 257–260). Association for the Advancement of Computing in Education. https://www.learntechlib.org/p/216903/

Abstract: "In this chapter we describe how educators can use internet-connected video game systems to support student learning. Specifically, we explain how teachers can leverage the private and party chat functions in the current models of the Xbox and PlayStation consoles for remote instruction. Private chat is a no-cost feature on Xbox and PlayStation consoles that allows the user to invite one other person to a private chat-room. Party chat allows the user to invite up to eight people to a private group chat-room. Resources are included for educators interested in learning more about using video game consoles and how to get started learning about online games. Future directions for researching teaching and learning using video game consoles are offered."

Krauskopf, K., Zahn, C., & Hesse, F. W. (2020). Concptualizing (pre-service) teachers' professional knowledge for complex domains. In T. Lehmann (Ed.), *International perspectives on knowledge integration: Theory, research, and good practice in pre-*

service teacher and higher education (pp. 31-57). Brill-Sense. https://doi.org/10.1163/9789004429499_003

Abstract: "In this chapter we integrate two lines of research that deal with complex knowledge domains, which are of increasing importance for pre-service teachers: Technology integration and responding to learner heterogeneity. Both domains are characterized by increased complexity, requiring pre-service teachers to understand concrete practice-related phenomena, as well as the underlying cognitive and socio-cognitive processes on a meta-level. In this context, initially we examine literature investigating the Technological Pedagogical Content Knowledge (TPCK) framework. Secondly, we provide an overview of the parameters for heterogeneity in the classroom, using three different approaches found in contemporary research. Thirdly, our considerations are integrated into both domains based on the notion of fragmented versus coherent theories. At this stage, we conceptualize how complex domains can be coherently mentally represented; arguing that teacher education needs to support pre-service teachers in their construction of professional knowledge, represented as coherent theories. Finally, we suggest an integrated perspective on pre-service teachers' professional development based on the concept of adaptive expertise. As a practical implication, we provide a basis for teacher training to guide pre-service teachers' meta-conceptual understanding of the potential of digital technology, and for dealing with heterogeneity in the classroom."

Lark, A. M., Pennock, R. T., & Richmond, G. (2020). The influence of instructor technological pedagogical content knowledge on implementation and student affective outcomes. In W. Banzhaf, B. H.C. Cheng, K. Deb, K. E. Holekamp, R. E. Lenski, C. Ofria, R. T. Pennock, W. F. Punch, & D. J. Whittaker (Eds.), *Evolution in action: past, present, and future* (pp. 551-570) Springer. https://doi.org/10.1007/978-3-030-39831-6_36

Abstract: "To investigate how instructors' technological pedagogical content knowledge (TPACK) influences the way they implement novel educational technologies and how this influences students' affective responses to the technology, we looked at how instructors with varying amounts of TPACK with regard to a specific educational tool—the digital evolution platform Avida-ED—implemented it in their classrooms. We then compared the nature of these implementations to student affective outcomes as measured by a post-implementation student survey. We found that the degree of instructor expertise influences implementation decisions, and that these decisions in turn influence student affect. Effective implementation of new educational technologies requires significant pedagogical knowledge, and warrants opportunities for training and professional development with regard to those technologies."

Lemanski, L., & Van Deventer, M. M. (2021). A framework for the redesign principles that improved engagement in an online graduate class. In Management Association, I. (Ed.), *Research anthology on developing effective online learning courses* (pp. 391-411). IGI Global. http://doi:10.4018/978-1-7998-8047-9.ch022

Abstract: "At a large, midwest university, the authors taught an online course to graduate students in an educational reading methods course. While the course covered compelling

content, the user experience frustrated students as they struggled to navigate an outmoded online learning management system (LMS), which inhibited their ability to engage with course content. Recognizing that the course could be a powerful and relevant learning experience for students, the chapter authors drew on engagement theory, technological pedagogical content knowledge (TPACK), and the triple E framework to redesign the course. While maintaining the valuable course content, the chapter authors developed a framework to create an engaging and positive online learning experience. This chapter describes the framework and details how the course was redesigned, articulates the rationale for the course changes, and explores the positive impact it had on teaching and learning."

McGee, K. E., & Welsch, J. G. (2020). Using technology to build interactions within and beyond the literacy classroom. In P. M. Sullivan, J. L. Lantz, & B. A. Sullivan (Eds.), *Handbook of research on integrating digital technology with literacy pedagogies* (pp. 260–286). IGI Global. https://doi.org/10.4018/978-1-7998-0246-4.ch012

Abstract: "Becoming an educator today, specifically one who teaches literacy, requires more than a strong understanding of pedagogy and best practices. Today's educators must be equipped to survive, as well as thrive, in a 21st-century literacy classroom. New programs, websites, apps, etc. are being introduced daily, therefore, our pre-service teachers need support in order to utilize tools effectively. By providing experiences with a variety of tools, novice teachers can employ existing pedagogical frameworks for technology integration with literacy instructional tools. This study identifies how pre-service teachers perceive their skills and pedagogical decision-making for the integration of technology tools within their literacy instruction."

Mitchell, C., & Appleget, C. (2020). Preservice teachers collaborating and co-constructing in a digital space: Using a participatory literacy practices to teach content and pedagogy. In J. S. Mitchell & E. N. Vaughn (Eds.), *Participatory literacy practices for P-12 classrooms in the digital age* (pp. 215–232). IGI Global. https://doi.org/10.4018/978-1-7998-0000-2.ch012

Abstract: "Participatory literacy practices include the ways in which individuals interpret, make, and share as a way of connecting in our digitally mediated culture. This chapter is a culmination of an across-university partnership created between the two authors and the pre-service teachers that collaborated online about teaching and learning. Three threads of participatory literacy practices are shared within the chapter including 1) the use of blogging across university settings, 2) the implementation of digital professional learning communities (PLCs) to connect and collaborate with other pre-service teachers, and 3) the formation and participation in digital literature circles to co-construct meaning from children's literature. This chapter includes the authors' attempts at collaboration across university settings using different tools, platforms, and resources. This work is an example for other teachers and teacher educators to consider how we can help pre-service teachers be part of the participatory culture and provide an even wider community of learners."

Özdemir, T. B., & Karal, H. (2021). Preparing future teachers for technology integration: Technology mentoring for pre-service classroom teachers. In M. D. Ramírez-Verdugo & B. Otcu-Grillman (Eds.), *Interdisciplinary approaches toward enhancing teacher education* (pp. 69-94). IGI Global. http://doi:10.4018/978-1-7998-4697-0.ch005

Abstract: "Over recent years, technological pedagogical content knowledge (TPACK) has been commonly used as a technology integration framework in both research and practice to support teacher knowledge in terms of instructional decision making in a technology-driven learning environment. This chapter focuses on collaboration between pre-service classroom teachers and ICT teachers. Within the scope of technology integration and by characterizing Computer Education and Instructional Technologies Department (CEIT) graduates as technology coordinators besides their ICT teacher role in Turkey, a collaborative process in which pre-service teachers from CEIT department work as technology mentor to those in the classroom teaching program was carried out. As a result of collaboration between pre-service teachers, due to the two-way interaction, it was expected that the pre-service classroom teachers could develop their knowledge in terms of TPACK and pre-service teachers from CEIT could able to have tangible experiences about the role they will take on in the future in the context of integration."

Poyo, S. R., & Ash, G. (2020). Practical, proactive and responsive teacher preparation for the virtual context. In R. E. Ferdig, E. Baumgartner, R. Hartshore, R. Kaplan-Rakowski, & C. Mouza (Eds.), *Teaching, technology and teacher education during the COVID-19 pandemic: Stories from the field* (pp. 387–390). Association for the Advancement of Computing in Education. https://www.learntechlib.org/p/216903/

Abstract: "This chapter describes the pragmatic actions and processes taken both proactively and reactively by one Educator Preparation Program (EPP) associated with the professional development of preservice teachers relative to instruction in both blended and online learning environments. Actions taken include programmatic curricular changes and collaborative partnerships with virtual learning school partners. Completion rate for Clinicals or student teaching was one hundred percent due to quick response and actions designed for success in the online classroom. Teacher preparation must include design and execution of instruction in online learning to address student learning needs and ensure classes continue without interruption."

Satu-Maarit, F. & Keskitalo, P. (2020). Enhancing social learning with digital applications: Life stance education and Sami pedagogy move to synchronous distance learning in teacher education. In R. E. Ferdig, E. Baumgartner, R. Hartshore, R. Kaplan-Rakowski, & C. Mouza (Eds.), *Teaching, technology and teacher education during the COVID-19 pandemic: Stories from the field* (pp. 23–26). Association for the Advancement of Computing in Education. https://www.learntechlib.org/p/216903/

Abstract: "This article explores how courses in life stance education and Sámi pedagogy in the primary school teacher education program at the University of Lapland were transferred online

mid-session due to the COVID-19 pandemic and how the lecturers (N = 2) and preservice teachers (N = 64) experienced distance learning. The lectures were organized so that the learning expectations were fulfilled, hence, the chosen applications supported interactive and dialogical working methods leading to social learning. The students' feedback was generally positive, and they were pleased that an interactive and dialogical atmosphere could be created with synchronous distance learning. Students also expressed that online learning put them under time pressure, made delimiting tasks more difficult, and induced in them a need for one-on-one supervision. Lecturers need to take these implications into account when planning and conducting online teaching. The process created a two-way-learning place for lecturers and preservice teachers alike."

Suters, L. (2020). Lessons learned from the transition to a virtual instructional technology course for elementary preservice teachers. In R. E. Ferdig, E. Baumgartner, R. Hartshore, R. Kaplan-Rakowski, & C. Mouza (Eds.), *Teaching, technology and teacher education during the COVID-19 pandemic: Stories from the field* (pp. 417–423). Association for the Advancement of Computing in Education. https://www.learntechlib.org/p/216903/

Abstract: "This chapter describes modifications to an instructional technology (IT) course for elementary preservice teachers (PSTs) when the course transitioned online Spring 2020. Recommended changes include synchronous online meetings, device-specific training sessions (Apple, PC, or chromebook), and the use of student choice and project-based learning. Descriptions of assignments modified for this online format and instruction during the pandemic including a technology tools spreadsheet, instructional movie, writing a children's text, a social studies menu, reflective discussions, and completing a project-based inquiry are included. Results of the TPACK survey yielded statistically significant increases for PSTs. Virtual office hours for one-onone assistance were helpful; however, students gradually transitioned to googling how to find their own answers in the online format which is not often observed in the traditional course. PSTs integrated and applied knowledge of the TPACK framework and SAMR model into the rationale for their culminating lesson plans for the course."

Vakil, J. B. (2020). Diving in the depth of online learning: How pre-service teachers leverage technology during the COVID-19 pandemic. In R. E. Ferdig, E. Baumgartner, R. Hartshore, R. Kaplan-Rakowski, & C. Mouza (Eds.), *Teaching, technology and teacher education during the COVID-19 pandemic: Stories from the field* (pp. 361–365). Association for the Advancement of Computing in Education.

Abstract: "Despite the rapid surge in full-time virtual schools across the nation, few teacher education programs address online teaching and facilitation competencies or offer virtual field experiences. With the sudden physical closures of schools due to the COVID-19 pandemic, such competencies are even more critical as pre-service teachers (PSTs) suddenly find themselves teaching online. This research brief describes the process of one teacher educator's weekly PST sessions as they rapidly transitioned to an online setting. Detailed are how Padlet discussions, Poll Everywhere, and timeless favorites of Bingo and Show and Tell were implemented to

enhance Technological, Pedagogical, and Content Knowledge (TPACK). Guided by the Community of Inquiry model, the pedagogical shift used during the new online sessions supported and modeled interactivity and social presence during synchronous and asynchronous activities."

Vasinda, S., Adams, H., James, K., Henry, A., Henson, T., McKinney, B., Mueller, E., Randolph, M. Taylor, J. (2020. Preservice teachers' use design-based research: Learning to tutor online during COVID-19. In R. E. Ferdig, E. Baumgartner, R. Hartshore, R. Kaplan-Rakowski, & C. Mouza (Eds.), *Teaching, technology and teacher education during the COVID-19 pandemic: Stories from the field* (pp. 367–372). Association for the Advancement of Computing in Education. https://www.learntechlib.org/p/216903/

Abstract: "University reading clinics provide inexpensive tutoring as a service to the community as well as serving as a supervised teaching practicum for preservice teachers. They also serve as a research lab for developing promising practices. As preservice teachers were becoming more and more proficient in their one-to-one teaching, all courses and our practicum moved online as a result of the COVID 19 pandemic. Our group of 17 preservice teachers and their instructor became a learning community engaging in design-based research using new tools to continue to serve our K-8 students. Several of these preservice teachers emerged as champions of the process and became class experts as well as trailblazers in this work. They share their resources and recommendations for online tutoring through a university reading clinic."

Wright, V. H., & Davis, A. (2016). Integrating technology in nurse education: Tools for professional development, teaching, and clinical experiences. In Management Association, I. (Ed.), *Teacher education: Concepts, methodologies, tools, and applications* (pp. 673-688). IGI Global. http://doi:10.4018/978-1-5225-0164-0.ch033

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."

4. Recent TPACK-Related Dissertations and Theses

Aldred, A. E. (2020). *Technology usage in the elementary classroom: A case study of teacher professional development and intentions for learning* (Publication No. 27741950) [Doctoral dissertation, Northeastern University]. https://doi.org/10.17760/D20350257

Abstract: "The expectations of teachers today have been greatly impacted by the ample number of technological devices and applications that are available for student learning. Programs on computers can be utilized to individualize math and reading topics based on students' academic levels. Technology can be used across the board within the different academic areas but the main factor on whether that is happening in the schools is the depth of knowledge educators have in using technology in their classrooms and how to incorporate it within their lessons with students. The overarching questions that drove this study were: "How are educator's incorporating technology into their classroom? How do educators describe their development in learning how to use educational technology? In order to gain more insight into this phenomenon, seven teachers, including general and special education, in an elementary school in central New Jersey shared their experiences of their technology integration within their classrooms as well as how they continue to develop their own technology skills. A Case Study approach was used to capture the depth of each participant's direct experiences. Throughout this study, four themes emerged: 1) 21st century technology instructional needs, 2) different levels of teacher technology knowledge, 3) lack of student technology knowledge, and 4) training and professional development needs. While these findings compare directly with the literature, there is also an opportunity for teachers to enhance their instructional strategies to match 21st century learning skills."

Alenazi, F. (2019). *The influence of TPACK on the perceptions of al-jouf University's pre-service mathematics teachers' future use of technology in the classroom* (Publication No. 27543168) [Doctoral dissertation, Southern Illinois University at Carbondale]. ProQuest Dissertations & Theses Global.

Abstract: "This study investigated the effect of pre-service teachers' perceptions of TPACK on their use of technology in their future classrooms. The participants of the study were 200 pre-service teachers enrolled in mathematics preparation programs at Al-Jouf University. Instruments used to collect the data were: a TPACK questionnaire-based survey and a semi structured interview. The results of this study indicated that preservice math teachers' perceptions are high in three domains which are TK, PK and TPK respectively and moderate in CK, PCK, TCK. The study also revealed that demographic factors were in general significant predictors of pre-service teachers' perceptions of TPACK. However, the study also revealed that preservice math teachers feel a sense of pressure to be able to teach with technology. Several recommendations were put forth for the Ministry of Education."

Alhejoj, K. (2020). *A multiple case study of college mathematics instructors' technological pedagogical content knowledge (TPACK) and its relationship to the integration to the integration of technology and communications technology (ICT) in their teaching practices and students' learning* (Publication No. 27838100) [Doctoral dissertation, Illinois Institute of Technology]. ProQuest Dissertations and Theses Global.

Abstract: "This multiple-case study aimed to investigate the following essential aspects of instructors' ICT integration in higher education: self-reported technological pedagogical content

knowledge (TPACK), level of ICT integration, and motivations-challenges to integrate specific ICT tools to teach particular mathematics concepts. Four college math instructors were selected purposefully from four community colleges. The TPACK conceptual framework was adopted through the use of the TPACK-M self-assessment survey to understand the perceived TPACK knowledge of the instructors. The model of Niess et al (2009), which describes the teacher's level of practical ICT integration in the light of their TPACK, assisted in exploring the way college math instructors used ICT. Data collection involved surveys, semi-structured interviews, and direct classroom observations. Quantitative data was analyzed using descriptive statistics, while Atlas.ti software was applied for qualitative data. The findings showed that the total TPACK-M was rated high, with TPK the lowest among all the constructs. In terms of the ICT integration model, one instructor fitted into the recognizing level, another into the adapting level, and two others into the accepting level. There was a misalignment between the self-reported TPACK knowledge and the in-class level of ICT integration. Instructors need more support in developing practical TPACK abilities via effective PD and activating the "teacher model" to help college math instructors integrate ICT in creative and successful practice. Also, more research in higher education is recommended using a larger sample in the area of designing a TPACK instrument for college math instructors to help capture their perceptions and recognize any gap between what they know and what they do in higher education contexts."

Antonelli, S. (2019). *Teacher perceptions of technological knowledge and pedagogy in mathematics instruction in a northeast state* (Publication No. 13865988) [Doctoral dissertation, Johnson & Wales University]. ProQuest Dissertations & Theses Global.

Abstract: "Educators are now charged with instructing students who are growing up in a digital environment (Hsin, Li & Tsai, 2014). Students need access to 21st century learning environments that incorporates technology use, especially in mathematics (Darling-Hammond, Wilhoit & Pittenger, 2014). Unfortunately studies show that technology integration is happening least in mathematics compared to other subject areas (Howard, Chan, & Caputi, 2015a; Howard, Chan, Mozejko & Caputi, 2015b; Howard, Chan, and Caputi, 2014). Moeller and Reitzes (2011) found that according to a National Center for Education Statistics study, only 23% of K-12 teachers feel prepared to integrate technology into instruction. The purpose of this sequential explanatory mixed methods study was to investigate and explore teacher perceptions regarding technology knowledge, content knowledge, pedagogy, and preparedness to implement technology integration in mathematics instruction in elementary teachers in an urban ring district in a northeast state.

This study addressed the following research questions: 1. How do elementary teachers rate their perceived knowledge of teaching and technology in mathematics on the following components of the Technological Pedagogical and Content Knowledge (TPACK) framework: technological knowledge (TK), content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), technological pedagogical content knowledge (TPACK), and models of TPACK related to preparedness? 2. Is there a significant difference in how elementary teachers rate their perceived knowledge of teaching and technology in mathematics on the components of the Technological Pedagogical and Content Knowledge (TPACK) framework by

the following demographics: gender, age and years of teaching experience? 3. How do elementary teachers describe their perceived technology knowledge, content knowledge, pedagogical knowledge, and preparedness to implement technology integration as they relate to mathematics instruction? The major themes that emerged from this study included limited teacher mathematics knowledge because mathematics instruction and expectations for understanding are different today than in the past; and teachers did not feel like they were supported or prepared well to integrate technology into mathematics instruction. Administration and teacher educators may benefit from knowing teachers feel a need to be supported in mathematics conceptual knowledge, problem solving and technology integration."

Amtallah, A. K. (2020). *Institutional factors influencing students' preparedness on integration of information and communication technology in teaching and learning: Case of Eregi Teachers Training College, Kenya* [Doctoral dissertation, University of Nairobi]. University of Nairobi Research Archive. http://erepository.uonbi.ac.ke/handle/11295/152963

Abstract: "The study purpose was to determine institutional factors that influence students' preparedness in integrating Information and Communication Technology (ICT) in teaching and learning: Case of Eregi Teachers' Training College, Kenya. Study objectives were to evaluate the extent ICT curriculum influence, determine the influence of college ICT infrastructure, and establish the extent of teacher educators teaching approaches on students' preparedness in teaching and learning with ICT integration at Eregi teachers' training college. Herein, a case study design was employed. The study population comprised of 565peoplehaving65teacher educators and 500 second year students. A representative of 20 and 100% of the2ndyear students and teacher educators, respectively, were purposively sampled. Hence, with the said proportions, a response rate of 95and 100% for second year students and teacher educators were achieved, respectively. Two sets of questionnaires on respective study participants were used in data collection.T he data on college ICT infrastructure and indicators of ICT integration in teacher education were evaluated through a focused group discussion guide and observation checklist. Validity and reliability of research instruments was determined by incorporating recommendations from supervisors and piloted on a few identical subjects not part of sample of the study using 10 percent of the sample size. Based on the reliability, a correlation of 0.88and 0.84were obtained from the teacher educatorsand2nd year students, respectively. SPSS version 20 was used to analyze the quantitative data and results presented in tables and pie charts, however, content analysis method was used to analyze qualitative data. As of the background information, basing on gender, the teacher educators was skewed towards the male while the student was skewed towards the females. Majority of teacher educators were above 40 years with a certificate in ICT. Notably, 61.6% of the teacher educators had teaching experience of over 20 years with either a Bachelor of Education or Masters in Education. However, with a combination of the factors, teacher educators appreciate the need of skills in teaching and learning using ICT. As worth mentioning, that from the study, students are fully exposed to the ICT curriculum design used; should be oriented in teaching and learning using ICT as it influences their preparedness. With adequate ICT

infrastructure in college, students are likely to be trained on them. Despite teaching practice being compulsory in teacher education, ICT use in teaching and learning is not a component in assessment of teaching practice. Moreover, it is handled casually as is never assessed. In adoptive perspective, policy makers and curriculum developers of teacher education can infuse ICT in all subjects but retain ICT subject for basic ICT skills. As a result to make ICT subject examinable in PTE, they should introduce assessment on use of ICT in teaching and learning as a component of teaching practice assessment, invest more in college ICT infrastructure and teacher educators to train on teaching approaches that contribute to ICT use in teaching and learning. Previous studies as demonstrated on other colleges had shown that they in fluence the teaching practice on teaching and learning integrated with ICT."

Aoyama, R. H. (2020). *Case study examining foreign language teachers' technological pedagogical content knowledge (TPACK) in teaching listening and speaking skills in virtual worlds* (Publication No. 27958494) [Doctoral dissertation, Northern Illinois University]. ProQuest Dissertations and Theses Global.

Abstract: "This qualitative study utilizes the lens of the Technological Pedagogical Content Knowledge (TPACK) framework to provide a holistic view of how language teachers demonstrate their TPACK in teaching listening and speaking in virtual worlds. Seven language teachers who taught in informal virtual language class settings participated in this study. The teachers' TPACK skills were examined through archived online chat transcripts for each observed class, one-on-one interviews with each language instructor, TPACK and demographic surveys, observation notes, and class documents from the instructors. The researcher took several steps to code the TPACK survey data to identify patterns by comparing the mean scores from each participant and then comparing across all participants. For other data, the researcher used in vivo coding to highlight specific words or phrases from the participants. The teachers demonstrated their Content Knowledge (CK) by spending time selecting articles or podcasts, their Technological Content Knowledge (TCK) by using a variety of teaching tools such as notecards and microphone, their Pedagogical Knowledge (PK) by using a wide range of teaching activities during the class to meet different learning styles, their Pedagogical Content Knowledge (PCK) by using learning materials based on their teaching experiences, their Technological Pedagogical Knowledge (TPK) by using authentic listening audio (podcasts) taken from the internet and supplementing it with subtitles, and their Technological Pedagogical Content Knowledge (TPACK) by combining technology and teaching approaches to teach the target language."

Bak, C. Y. (2015). *Transforming teaching and learning with technology: A case study of a California public school* (Publication No. 27794606) [Doctoral dissertation, University of Southern California]. ProQuest Dissertations and Theses Global.

Abstract: "This study applies the Technological Pedagogical and Content Knowledge (TPACK) framework and Substitution Modification Augmentation and Redefinition (SAMR) model to understand how technology can be used as a tool to transform teaching and learning in a public

school. The purpose of this study was to identify the impact of technology on teaching and learning at a K-8 school. The research questions included: (1) What technology is present and how is it used as a tool of instruction in the classroom? (2) What is the perceived impact of technology on teaching and learning? (3) In what ways does the school climate support the integration of technology? Where does the leadership come from? This qualitative case study was designed to identify the practices and culture of a school through multiple sources of data, including a survey, document reviews, interviews, and classroom observations. Findings from the study identified frequent use of iPads, laptops, and interactive white boards to differentiate learning and provide students with hands-on learning experiences and self-guided practice, high levels of engagement and students taking ownership of the learning, shift in the role of the teacher from expert to learner and facilitator, and shared leadership among teachers and administrators. The five emergent themes in the study were (1) visionary leadership and shared decision-making (2) shared vision and clear expectations for technology (3) teacher as facilitator of learning (4) ongoing professional development and a culture of collaboration (5) importance of support from the district and local community."

Barton, P. (2020). *Elementary school teacher characteristics associated with self-efficacy for using technology to implement constructivist content instruction: An exploratory correlational study* (Publication No. 27831408) [Doctoral dissertation, Northern Illinois University]. ProQuest Dissertations and Theses Global.

Abstract: "Technology mediated constructivist practices may be effective, but there are challenges for implementing them, and one challenge is the teachers themselves and their self-efficacy. Teachers of different backgrounds may differ on self-efficacy in technology mediated constructivist practices, and those possible differences can warrant different training approaches. For this study, 212 K-5 teachers from small to medium sized rural and suburban school districts in the Midwestern US, as well as teachers from a variety of other geographic areas, completed an online survey. The dependent variable self-efficacy in Technological Pedagogical and Content Knowledge (SE-C-TPACK) was regressed on the independent variables. The independent variables were self-efficacy in constructivist content knowledge (SE-C-CK), self-efficacy in constructivist pedagogical knowledge (SE-C-PK), and self-efficacy in constructivist technology knowledge (SE-C-TK), personal characteristics of age and sex, and professional characteristics of level of education, content focus, and years of service. While many of the relationships were not statistically significant, this study replicated a prior finding about the relationship between years of service and SE-C-TPACK with teachers in their first five years of service having a slightly higher level of SE-C-TPACK. In addition, this study replicated findings from other TPACK studies showing relationships between both Technology Knowledge and Pedagogical Knowledge and TPACK."

Boniface, A. (2020). *Breaking the code: A narrative inquiry into creating and implementing computer science curriculum into elementary classrooms* (Publication No. 27963661) [Doctoral dissertation, Northern Arizona University]. ProQuest Dissertations and Theses Global.

Abstract: "Many elementary teachers are required to teach computer science and coding. However, many teachers do not have the technology skills, curriculum resources, or training support to effectively integrate technology into their instruction. The goal of this study is to contribute to the literature that provides researchers, teachers, and curriculum makers with ways to develop elementary computer science curriculum, engage teachers in collaborative professional development, and effectively integrate technology into classroom instruction. This research utilizes narrative inquiry as a methodology to highlight the processes of computer science curriculum construction, teacher collaboration within a training context, and implementation of curriculum in elementary classrooms. Schwab's commonplaces provide a framework to unpack teachers' stories related to curriculum development. Communities of practice and TPACK provide frameworks for teacher collaboration and classroom implementation. Stories of experience reveal how teachers collaborate with peers and use their knowledge to make instructional decisions that meet the needs of students. This research reveals how the context of life in schools affects the ways that teachers view computer science curriculum, technology training, and classroom implementation of integrated technology curriculum. Teachers want hands on training that allow them to engage in collaborative dialogue with peers and experts. Additionally, teachers benefit from collaborative and ongoing professional development models where a mentor is available to model or co-teach the content while engaging in dialogue about instructional decisions and pedagogical skills. Teachers benefit from curriculum that supports and enhances their knowledge of computer science content and technology platforms. However, teachers value flexibility within the curriculum to make instructional decisions that accommodate the unique needs of their own comfort levels with technology, the diverse needs of students, classroom technology barriers, and time constraints. Recommendations are included for additional research that explores how new literacy curriculum construction, teacher collaboration, and curriculum implementation are affected by life in schools. Recommendations are included to further explore how students, specifically English Language Learners and students with specials needs, benefit from computer science curriculum that integrates literacy content, project planning, creativity, and problem-solving. Teachers who integrate computer science into their instruction are encouraged to stay the course and continue making positive strides in the effort to prepare students for life in the 21st century."

Camberos Rangel, D. M. (2019). *Analyzing teachers' technological pedagogical and content knowledge* (Publication No. 27666832). [Doctoral dissertation, The University of Texas at El Paso]. ProQuest Dissertations & Theses Global.

Abstract: "This qualitative study analyzes the ways a professional development course entitled Sol y Agua helped teachers to acquire technological, pedagogical, and content knowledge (TPACK) and to implement technology in their classroom. This study also analyzes the experiences teachers had in the workshop and the recommendations they had to improve the workshop. TPACK is a framework which denotes that teachers have a deep understanding of how to represent content using technology, and that the technology is used effectively to teach the content knowledge. Technology is integrated as a component of the teacher content knowledge and the teaching topic, and not as an accessory of it or a simple addition to it. For

TPACK integration, it is required that teachers understand pedagogy, content, and technology, not in isolated but in combination with each other. This study uses the case study approach in order to explain how teachers perceive the Sol y Agua workshop through in-depth interviews, focus group interactions, and a survey that was used to evaluate teachers' experiences with the TPACK framework. The findings will impact the micro-level by giving the creators of Sol y Agua evidence to improve the workshop, as well as impact the macro-level by exposing TPACK elements that can be incorporated in future teacher professional development courses infused with technology."

Cui, J. (2020). *Science teachers' instructional design practices for a bring-your-own-device (BYOD) environment in New Zealand secondary schools* [Doctoral dissertation, University of Auckland]. University of Auckland Research Repository. https://researchspace.auckland.ac.nz/handle/2292/54062

Abstract: "An increasing number of New Zealand schools have introduced and implemented bring-your-own-device (BYOD) initiatives, a significant trend in New Zealand education. A considerable body of literature and emergent practices have demonstrated how teachers' effective instructional design practices can influence students' abilities to learn and students' educational attainment. Some research has been carried out on the impact of technology integration on students' attitudes and learning performance as well as the influence of teachers' professional learning and development in BYOD environments. However, little is known about teachers' instructional design practices for a BYOD environment. This study aims to understand science teachers' instructional design practices for BYOD environments in New Zealand secondary schools. It explores teachers' practices in a BYOD environment and offers new insights into New Zealand BYOD initiatives. The qualitative study included three phases: Phase 1, analysis of 222 New Zealand secondary schools' documents related to BYOD; Phase 2, an open-ended survey completed by 72 science teachers; and Phase 3, semi-structured interviews with 12 science teachers and three experts in the field of New Zealand secondary science education. Document analysis was used for Phase 1 and thematic analysis for Phases 2 and 3 data. The Phase 1 findings showed that 222 out of 347 New Zealand secondary schools (64%) had adopted BYOD initiatives at the time of the study. Collating and analysing 837 documents from these 222 schools revealed seven categories of information, including: vision, enrolment, news, reports, general information about BYOD, information on responsible use of technology in a BYOD environment, and technical instruction. The findings from Phases 2 and 3 linked macro-, meso-and micro-level contextual factors with teacher knowledge, perceived affordances and constraints, professional learning and development, engagement, and instructional design practices. The study found that participating teachers attached more importance to knowledge of technology and pedagogy than content. When reviewing these teachers' instructional design practices within the ADDIE (analysis, design, development, implementation, evaluation) framework, their analysis and evaluation phases appeared to consistently inform the three phases of design, development, and implementation. Finally, with reference to the SAMR (substitution, augmentation, modification, redefinition) model, most participating teachers characterised the extent of their technology use as either modification or redefinition, as they generally felt confident and comfortable with their current teaching with

technology. These findings provide insights and practical implications for teachers, schools, teacher education providers, and policymakers, as well as guidance for future studies of BYOD and in the broader field of technology in education."

Dhindsa, N. (2020). *Teach-to-one blended mathematics' impact on middle school students' mathematics achievement* [Doctoral dissertation, Walden University]. Walden University ScholarWorks. https://scholarworks.waldenu.edu/dissertations/9482/

Abstract: "Blended learning that integrates computer-assisted instruction with face-to-face instruction is gaining popularity in U.S. middle schools; therefore, the effectiveness of such blended learning models in improving middle school students' achievement in mathematics needs to be explored. Middle school students at a public Connecticut school have shown poor performance in mathematics on a state standardized test. The local district implemented a blended learning model, Teach to One: Math (TTO), in 1 of the middle schools to improve students' performance in mathematics. The theoretical framework for this study was Koehler and Mishra's theory of technology, pedagogy, and content knowledge. The key research question of this study examined if there is a statistically significant mean difference in the observed growth scores of the TTO students in School A compared to non-TTO students in School B as measured by the Measures of Academic Progress (MAP) mathematics assessment during the 2017-2018 school year. In this quantitative study, a quasi-experimental, nonequivalent, control- group design was used with a sample size of 1,341 participants. The archival data obtained from the local district were analyzed using an independent samples t test to determine if there was a statistically significant difference between the means of the 2 unrelated, TTO and non-TTO groups. The findings of the study indicated no significant difference between the observed growth of TTO and non-TTO students as measured by the MAP mathematics test. This study contributes to positive social change by providing data to guide the local district on whether TTO should be implemented in the other middle schools in order to improve students' achievement in mathematics."

Ejimole, D. O. (2019). *Faculty technological pedagogical content knowledge, and instructional adaptations for diverse learners* (Publication No. 27663372) [Doctoral dissertation, California State University]. ProQuest Dissertations & Theses Global.

Abstract: "The rising trend in diverse student populations and ubiquitous digital technology are prevalent in contemporary U.S. society and are pervading the country's universities and colleges. The diverse student population encompasses typical and atypical students with varying cultural and linguistic backgrounds, coupled with different learning styles and abilities, as well as those known today as "nontraditional" students. On the other hand, the advent of digital technology into the education sector is well known, and the tool is believed to be powerful for transforming learning with the potential to provide authentic learning experiences for all learners when fully harnessed and integrated into the educational system (curriculum). Yet, precisely how higher education faculty integrate and use technology in their instruction to position all students on the path to academic success is not clear. This study is focused on the instructional challenges of this increasingly diverse student population on postsecondary

education faculty. It specifically explored faculty knowledge and skill base in technology, pedagogy, and content, as well as how it plays into their instructional practices in the specific context of a diverse student learning environment. Findings and implications for future practice were discussed."

Doherty, B. (2019). *The role of content, pedagogical, and technological knowledge in explaining music teacher self-efficacy* (Publication No. 13813724) [Doctoral dissertation, Manhattanville College]. ProQuest Dissertations & Theses Global.

Abstract: "This quantitative study examined the self-efficacy of music teachers in each of the technological, pedagogical, and technological knowledge (M-TPACK) domains with a particular focus on their technological self-efficacy. Bauer's (2013) M-TPACK questionnaire was used as its measurement tool and was sent to members of the National Association for Music Education. Overall, respondents reported high levels of self-efficacy when implementing technology in their instruction. In addition, this study revealed that music educators were discovering technology, as well as learning to use it, mostly during their own time and outside of school hours. This study further validated the factor structure of Bauer's M-TPACK survey as it pertains to music teachers for the questions measuring each of the individual TPACK domains. Some additional findings include that male music educators may have greater self-efficacy in using technology in their instruction, and also that technology knowledge might potentially be even more important to the overall self-efficacy of music teachers than either content or pedagogical knowledge. A possible explanation for this could be that effective and appropriate use of technology may also increase student engagement, thus perpetuating a positive cycle of successful teaching and learning. The implications of this study also suggest that previous models of teacher self-efficacy, which did not include technological self-efficacy, may not be reflective of current-day music teachers. Further research is needed regarding technology as it used in the various areas of music education."

Ejoh, D. (2020). *Influence of mathematics teachers' technology use on secondary students' motivation, attitude, and achievement in Nigeria* (Publication No. 28261806) [Doctoral dissertation, Walden University]. ProQuest Dissertations and Theses Global.

Abstract: "Students in Nigeria are not finishing school with the math skills needed for gainful employment and economic self-reliance, possibly due to a lack of technology use in math classes. Specifically, the influence of technology use in math classrooms on students' motivation, attitude, and math achievement in Nigeria was not well understood. Guided by the technological, pedagogical, and content knowledge (TPACK) theoretical framework, the purpose of this ex post facto, causal-comparative study was to compare the differences in student motivation, attitude, and achievement scores between students in math classrooms with low technology use and students in classrooms with high technology use in 3 private secondary schools in Nigeria. All secondary level math students (N = 398) completed the Motivational Strategies for Learning Questionnaire and Attitude Towards Mathematics Inventory. Of those, the 72 graduating students who completed the West African Secondary School Certificate of Examination served as the sample for math achievement. Mann-Whitney U

tests showed motivation, attitude, and math achievement scores were all significantly higher (p = .00) for students taught in high technology use classrooms than in low technology use classrooms, indicating technology integration had a positive influence. Findings suggest that with heightened technology integration in math classes, positive social change can occur as students may be more likely to gain the math skills necessary for enhancing their future employment opportunities and economic self-reliance. With these superior outcomes, positive economic growth and development in Nigeria may be enhanced over time."

Finder, J. A. (2020). *Helping future teachers do history: The effectiveness of the National Archives DocsTeach Program on the historical thinking and perception of history of preservice teachers* (Publication No. 27828856) [Doctoral dissertation, University of South Carolina]. ProQuest Dissertations and Theses Global.

Abstract: "The purpose of this action research was to evaluate the implementation of the National Archives DocsTeach program as a means of increasing the historical thinking of preservice teachers enrolled in a social studies methods course. In this study, six students enrolled in a social studies methods course at a regional southeastern university participated in a four-class long unit centered on the use of the National Archives DocsTeach program. The National Archives DocsTeach program is an immersive program that provides teachers with access to a national level repository of digitized primary sources and corresponding instructional resources (Chen, 2015; Ward, 2012). Prior to the unit, students completed a document-based question preassessment and a perception survey about history. Participants completed one activity within the National Archives DocsTeach program for four classes. During the activities, anecdotal observations focusing on the participants' collaboration and engagement in the activities were collected. At the conclusion of the unit, participants completed another document-based question to serve as a post-assessment, a perception survey about history, a perception survey about the DocsTeach program, and an exit interview. The quantitative and qualitative data were analyzed to determine that the DocsTeach program had a positive impact on the participants' historical thinking and perceptions of history. The participants' perception of using the National Archives DocsTeach program as an instructional resource in their future classroom was also determined to be positive."

Foley, T. (2020). *Faculty and student attitudes and experiences of blended learning in postgraduate programmes: A case study in an Irish university* (Publication No. 28044895) [Doctoral dissertation, University College Cork]. ProQuest Dissertations and Theses Global.

Abstract: "While technology has undoubtedly increased the breadth and depth of access to education, shifts of this magnitude need reconstruction of approach from faculty and administrators in higher education to rethink the pedagogy for the twenty-first century learner who require such skills as critical thinking, problem solving and the ability to communicate through different media where the face-to-face lectures still dominate teaching practice. In this exploratory study, a case study approach was used to investigate the implementation of blended learning with a group of students on their postgraduate programmes and explore the

influence blended learning is having on both faculty and student experience. This study explores the challenges and benefits of a holistic approach to digital learning for a modern university. In conducting this study, the TPACK model of Mishra and Koehler (2006) and the Multimodal Model by Picciano (2009) form the basis of the conceptual frameworks adopted as these were deemed the most relevant frameworks because of their pedagogic dimension. The themes identified included the need for face-to-face interaction, course structure, induction and providing adequate support. Challenges arose due to isolation with the physical distance between the instructor and students, using technology to communicate on forums, workload, lack of training, time management issues and the ongoing need to provide a variety of assessment methods and subsequent feedback. Blended learning is endorsed as a strategy that helps to create a more integrated approach for both instructors and learners. What also emerged was that a holistic, seamless and well integrated blended learning approach using pedagogically appropriate models and more active learning, provided faculty the opportunity to engage students in a richer, deeper, and more meaningful context. Overall, students valued this learning and assessment strategy and viewed the online environment as an inclusive space in which to collaborate and share ideas where they had the option to share knowledge and interact with each other beyond the confines of the classroom where the significance of the pedagogy takes priority over and above the efficiency aspect. This study concludes that blended learning can be considered as an efficient approach to distance learning in terms of students' learning experience where pedagogy transcends technology. The evidence would suggest that effective blended learning does not entail merely 'toying with technology' and adapting it into pre-exiting courses where it may serve no pedagogical value. The relationship between content, pedagogy and technology is fundamental, thus, the implementation of powerful blended learning may necessitate changes in pedagogy and the relationship between students and educators."

Gettman, S. L. (2019). *A quantitative study of the impact of professional development on teacher technology integration* (Publication No. 13806034) [Doctoral dissertation, University of Phoenix]. ProQuest Dissertations & Theses Global.

Abstract: "School districts have spent millions on technology tools and trainings. Yet, half of teachers still feel unprepared to utilize technology in the classroom. The primary barrier to technology has shifted to teacher belief—composed of teaching philosophy, technology skills, and experience with technology. Technology-based professional development must integrate a theoretical framework which directly addresses the role of technology in order to fully support teacher technology integration. Moreover, technology-based professional development requires new models to counteract the focus on skills acquisition. The researcher used the TPACK (Technological, Pedagogical, and Content Knowledge) framework— conceptualizing instruction as a blending of technology, pedagogy, and content- to support participants in evaluating their own practice. Additionally, the researcher investigated supplemental supports for professional development, modeling and mentoring, on technology integration. The researcher used the Technology Integration Assessment Rubric (TIAR), based on the TPACK framework, to measure changes in technology integration. Comparison of pretest and posttest TIAR scores found TPACK-based professional development raised TIAR scores by 0.37 (*SE* =

0.051, $p < 0.001$). Analysis of the mean posttest TIAR scores for the supplemental supports showed mentoring ($M = 2.47$), modeling ($M = 2.29$), and modeling and mentoring ($M = 2.27$) scored higher than the control group ($M = 2.17$), but were not statistically significant. Based on the results, the researcher asserts the need for theory-based support for technology integration and school districts to incorporate TPACK into the core principles guiding instructional technology departments. Further research is needed regarding the evolution of diverse models for professional development."

Hernandez, R. N. (2020). *#Generation Z: A phenomenological study exploring the experiences of elementary Title I teachers' use of educational technology in the 21st century classroom* [Doctoral dissertation, Liberty University] Liberty University Scholars Crossing. https://digitalcommons.liberty.edu/cgi/viewcontent.cgi?article=3726&context=doctoral

Abstract: "The purpose of this transcendental phenomenology was to describe the experiences of teachers' educational technology use in Title I elementary schools in Central Florida. The central research question in this study was: How do Title I elementary teachers in Central Florida describe their experiences utilizing educational technology in the classroom? The theoretical foundation for this study was grounded in Bandura's social cognitive theory, more specifically teacher self-efficacy, which is a significant component of social cognitive theory. The design of this study was a transcendental phenomenology, a qualitative model that is most appropriate since I sought to make meaning from the descriptions of teachers' use of educational technology in the Title I classroom. The sample consisted of 15teachers from Title I schools across Central Florida. I collected data using in-depth personal interviews, focus groups, and journal prompts. The data was analyzed through phenomenological reduction. Findings from this study revealed how the Title I teachers utilized technology in their elementary classrooms to prepare their students for college or careers. The research revealed the importance of technology training and administrative support for teachers to be able to integrate technology into their classroom curriculum effectively. Recommendations for future research include expanding the study to comprise more Title I schools and exploring the effects of remote learning for students should the need arise for distance learning."

Holt, A. J. (2019). *Professional development in the wild: Evaluating emerging elements of the breakout EDU community that can inform an improved model of formal TPACK framed teacher professional development* (Publication No. 27540683) [Doctoral dissertation, Pepperdine University.] ProQuest Dissertations & Theses Global.

Abstract: "Teachers face challenges as they plan learning activities that meet content area standards, encourage students to collaborate while inspiring critical thinking and creativity. Limited time and resources make it difficult to incorporate new instructional approaches and technologies. Many feel that professional development is ineffective. Consequently, teachers turn to social media such as Facebook, Pinterest, Twitter, etc. for professional learning. One educator group that has grown phenomenally is the BreakoutEDU community.
This study identified emerging elements of the Breakout EDU (BEDU) Community for professional learning that can inform the Technological, Pedagogical, and Academic Content

Knowledge (TPACK) framework for teacher professional development (PD), advancing toward an improved vision that constructively engages today's teachers.

Two lenses were applied for this study. The first was 18 months of BEDU Facebook discourse. The researcher selected representative conversations that illustrate qualities of professional learning occurring in the virtual community. The second lens was through a survey taken by community members. The results were integrated to answer the research questions.

The study shows teachers are actively sharing resources, asking questions, even discussing pedagogical strategies. Educational social media groups such as BEDU are providing "just in time" learning that fit within identified characteristics of effective PD: choice, collaborative, ongoing, active learning, content-specific.

These findings led to 4 key conclusions. First, social media is a viable form of PD for teachers. Second, teachers are utilizing social media groups to provide ongoing professional learning. Third, characteristics of professional learning within educator social media groups can be applied to TPACK framed professional development. Finally, providers and planners of district PD can be improved by adopting innovative, creative approaches that include the characteristics of effective professional development, including learning on social media. It is time for traditional professional development to be reimagined, to empower teachers in their learning choices, and to seek innovative approaches to TPACK framed professional learning."

Jang, J. E. (2019). *Reimagining technology preparation for pre-service teachers: Exploring how the use of a video self-analysis instructional component, based on the evidential reasoning and decision support model, impacts pre-service teachers' technological pedagogical content knowledge* (Publication No. 27548838). [Doctoral dissertation, Syracuse University]. ProQuest Dissertations & Theses Global.

Abstract: "Teachers often teach on their own in their individual classrooms and thus have to mostly rely on themselves to reflect on their teaching practices and make improvements. This study explores how the use of a video self-analysis instructional component, based on the evidential reasoning and decision support model (ERDS), impacts pre-service teachers' technological pedagogical content knowledge (TPACK). Using the explanatory sequential mixed methods design, the researcher first collected quantitative data. The collection of qualitative data then followed. This two-step process helped explain and elaborate on the quantitative results of this study. Participants in this study were 21 pre-service teachers enrolled in the third and final required technology integration courses during the 2016 fall semesters. Data sources used for this study included surveys, videotaped teaching samples, reflective essays, and semi-structured interviews. Results from the study indicate statistically significant improvements in participants' self-perceptions towards their content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and overall TPACK. Except for TK, the self-perception of all TPACK domains statistically significantly increased with medium to large effect sizes. Every participant in this study (n=21/21) cited that their ERDS guided video self-analysis was beneficial in informing their technology integration lesson planning process because the videos enabled them to observe their actual teaching practices. As a result, the pre-service teacher participants were able to critically assess their TPACK strength and limitations. In

addition to changing participants' TPACK perceptions, the participants also applied the lessons learned from their ERDS guided video self-analysis to actually change and improve their technology integration skills. For example, 85.7% (n = 18/21) of the participants actually changed their instructional behaviors based on their self-prescribed action plan they outlined in their technology-enhanced lesson plans. The findings from this study suggest that the use of an ERDS guided video self-analysis instructional component was beneficial in helping pre-service teachers improve their ability to teach with technology because 1) it helped them challenge their own preconceptions of their TPACK; 2) enabled them to critique their own teaching and technology integration skills and; 3) provided them with authentic and accurate depictions of technology integration skills (e.g., videotaped lessons) so they could accurately prescribe a specific plan of action to improve their future technology-enhanced lessons. While this is only one study within a specific context, the results from this research suggest it may be worthwhile for scholars and teacher educators to continue examining the effects of using an ERDS guided video self-analysis instructional approach to improve teachers' TPACK and technology integration skills."

Kang, L. (2020). *Developing technological pedagogical content knowledge (TPACK) for teachers of Chinese: A mixed methods study* (Publication No. 28259180) [Doctoral dissertation, University of Nebraska-Lincoln]. ProQuest Dissertations and Theses Global.

Abstract: "This mixed methods study explored the development of technological, pedagogical, content knowledge (TPACK) of Chinese teachers who attended the STARTALK Chinese Teacher Institute, a 10-day residential summer professional development program at the University of Nebraska-Lincoln. A sequential explanatory design was adopted in which quantitative and qualitative data were collected and analyzed. The initial quantitative phase consists of survey data from both pre and post measures. The quantitative data helped identify the impact of the professional development program on the participants' TPACK development and purposefully select the informants for the second phase. Then a qualitative approach with open-ended questions on the survey, journals, lesson plans, and interviews of the participants was conducted in the second phase to further explain and explore the findings from the first phase. Thus, the quantitative data and results provided a general picture of the effect of the program, while the qualitative data and its analysis refined and explained those statistical results by exploring the participants' TPACK development in more depth. The Technological Pedagogical Content Knowledge framework (TPACK) (Mishra & Koehler, 2006) was adopted as the theoretical lens for this research, and its principal components guided the quantitative and qualitative data analysis. The majority of the scales in the quantitative instruments reported significant growth in participants' TPACK knowledge. The qualitative data reported positive learning experiences throughout the program in all TPACK-related areas, such as context, pedagogical beliefs, technological beliefs, content knowledge, pedagogical knowledge, pedagogical content knowledge, technological knowledge, technological content knowledge, technological pedagogical knowledge, technological pedagogical content knowledge, teaching practices, and assessment. The findings from both the quantitative and the qualitative strands provided a deeper and more detailed picture of the phenomenon that would not have been achieved with either approach alone. In addition, the merged data analysis comparison

unveiled congruencies and discrepancies between the quantitative and the qualitative data that enabled a more complete and deeper understanding of the research questions."

Kyllönen, M. (2020) *Use and acceptance of technology: Teachers' digipedagogical skills* [Doctoral dissertation, University of Jyväskylä]. JYX Digital Repository. http://urn.fi/URN:ISBN:978-951-39-8057-3

Abstract: "The aims of the thesis were to examine Finnish teachers' digipedagogical skills and to identify factors contributing to teachers' development in these skills, and their acceptance of use of technology in pedagogy. The data were collected in the context of crafts. Two theoretical models, the Technological-pedagogical-content knowledge framework, TPACK (Mishra & Koehler, 2006), and the Unified Theory of Acceptance and Use of Technology, UTAUT (Venkatesh et al., 2003) were applied. TPACK model was used as the theoretical framework for conceptualizing and assessing teachers' digipedagogical skills, and UTAUT was utilized in analysing factors enabling teachers' technology use. A mixed methods approach was utilized. First, quantitative data were collected on teachers' digipedagogical skills using a TPACK-survey (n=97). Second, semi-structured thematic interviews of five teachers were collected in the preand post-phase of a professional development (PD) module. Technological skills (TK), pedagogical skills (PK), content related skills (CK), and the overlapping area of TPCK formed the focus of scrutiny when examining teachers' perceptions of their technology use and factors affecting it. The analysis of the interview data was theoretically driven by utlilising the constructs outlined in the UTAUT model (Venkatesh et al., 2003). The results of the research suggested that in-service teachers' perceptions of their use of technology emphasized more strongly pedagogy than technology or technology related contents. Digipedagogical skills were connected with teachers' age, work-, teaching- and crafts teaching experience. Enablers of technology acceptance and enablers of technology use were identified. Acceptance was found to draw from perceived technological self-efficacy and beliefs of pedagogical usefulness of technology. Enablers of technology use included technical or personal support from others such as employer or family for an example. Based on the findings a novel pedagogy driven model was constructed. The developed model of Digipedagogical skills and enablers of use and acceptance of the technology and the results can be used to plan and implement teachers' preand in-service training promoting strengthening of digipedagogical skills."

Levy, H. (2019). *Assessing the technological pedagogical content knowledge (TPACK) of teachers in modern orthodox Jewish day schools* (Publication No. 27773287) [Doctoral dissertation, Yeshiva University]. ProQuest Dissertations & Theses Global.

Abstract: "Teachers in Jewish day schools have made significant efforts to integrate technology into their educational methodology over the past twenty years. However, studies had not yet explored whether these teachers possess the requisite knowledge to utilize educational technology effectively to enhance learning. Mishra and Koehler's technological pedagogical content knowledge (TPACK) is the premier framework portraying the types of knowledge required to integrate technology in teaching one's content area. TPACK is based on the interplay of three types of knowledge: content knowledge, pedagogical knowledge, and

technological knowledge, which come together to form TPACK, along with other secondary knowledge constructs. The current study seeks to ascertain the self-reported TPACK of teachers in Modem Orthodox Jewish day schools. In addition, correlations were sought between self-reported TPACK and the in-service professional development and pre-service teacher training of these teachers. Further, the study questioned whether teachers with high levels of self-reported TPACK integrated technology in notably different ways than those with lower levels of self reported TPACK. Upon an analysis of all the data, the study sought to identify which variable among those studied was the strongest predictor of self-reported TPACK. In analyzing the responses of 109 teachers, the results found self-reported TPACK levels to be high, with no significant discrepancies among any of the demographic variables. Correlations were found between self-reported TPACK and in-service professional development and pre-service teacher training. Teachers who report high levels of TPACK also claim to use technology in notably different ways than those who report lower levels of TPACK. Within the TPACK framework, technological pedagogical knowledge was the strongest predictor of TPACK, followed by technological content knowledge. From all the variables surveyed outside of the TPACK framework, nature of technology integration was the strongest predictor of self reported TPACK, followed by hours of in-service professional development. The current study aims to assist Jewish day schools by clarifying what types of knowledge teachers in Modern Orthodox Jewish day schools possess in regards to technology integration. Due to the wide scope of the study, future research is required to delve deeper into these findings. In addition, given the multitude of factors that play a role in technology integration, future research studying factors such as pedagogical beliefs, accessibility of technology, and school culture, is required to attain the complete picture regarding technology integration in Modern Orthodox Jewish day schools."

Nelson, M. J. (2020). *The effects of classroom and field experiences with technology on preservice teachers' beliefs and teaching practices* [Doctoral dissertation, The Ohio State University]. OhioLINK.
http://rave.ohiolink.edu/etdc/view?acc_num=osu1585946911420285

Abstract: "Recently, the United States Department of Education and the main accreditation body of teacher education in the US have called for new teachers to beprepared to effectively use technology upon graduation. To accomplish this, the literature emphasizes targeting their beliefs about technology's value and their abilities to use it. Until now, studies focused on changing these beliefs have largely explored classroom interventions rather than the effect of an entire teacher education program. Furthermore, the traits of the teacher educators and the actions of mentor teachers in the field are often overlooked, with the focus emphasizing specific approaches to technology integration training. To address this gap, this study used online surveys to sample preservice teachers across ten different institutions regarding their field experiences, university coursework, personal beliefs, and application of Technological Pedagogical Content Knowledge(TPACK)in their student teaching placements. Analyses with structural equation modeling indicated that preservice teachers' intrinsic interest and beliefs in the utility of technology in education predicted their application of TPACK. Additionally, their self-efficacy to improve student learning with technology predicted all value beliefs as well as

preservice teachers' TPACK application. Regarding the impact of a teacher education program, preservice teachers who rated the Teacher Educator Technology Competencies (TETCs) as prevalent in their coursework had higher self-efficacy and greater levels of TPACK application. Surprisingly, the prevalence of TPACK in field experiences did not impact any of the studied beliefs, though it directly predicted their personal TPACK application."

Nelson, R. (2020). *Examining preservice teacher technology development during the COVID-19 pandemic* (Publication No. 28091622) [Doctoral dissertation, University of Texas at San Antonio]. ProQuest Dissertations and Theses Global.

Abstract: "As education faces abrupt changes due to the COVID-19 pandemic, the knowledge preservice teachers need to effectively integrate technology has become critical. This study examined how the instructional experience influenced the development of T-dimensional self-efficacy in preservice and clinical teachers. Further, the study identified T-dimensional development using the demographic, program, and construct variables within a teacher education program currently restructuring its technology integration efforts. A longitudinal, quantitative research survey was administered as a pre-post-survey to preservice teachers during traditional face-to-face instruction in Fall 2019 and clinical teachers in emergency remote learning in Spring 2020. Clinical teachers had a statistically significant increase in TPK self-efficacy from pre to post-survey, during emergency remote learning. Pre-survey results indicate preservice teachers reported lower self-efficacy in all T-dimensions compared to clinical teachers with a statistically significant difference between the two groups' TCK self-efficacy. However, preservice teachers outperformed clinical teachers in all T-dimensions after participating in the traditional face-to-face instruction, compared to clinical teacher's participation in emergency remote learning. Further, in order to develop a more in-depth picture of TPACK within the teacher education program, Kruskal-Wallis H Tests were used to examine the differences in TPACK across gender, age, race, program, and intended certification level. The tests identified a statistically significant difference in TPACK by age groups. While not statistically significant, preservice and clinical teachers across all subpopulations reported the least self-efficacy in TK. A lack of systematic integration of technology into a stand-alone technology course or across methods courses is likely the cause. Finally, a multiple regression analysis revealed that all constructs significantly predicted TPACK, however, TPK, PK, and PCK explained the majority of variance in the clinical teacher's TPACK development. Thus, a continued focus on pedagogical knowledge with and without technology may support preservice teachers' TPACK development. Future research and program implications are discussed."

Onyegwara, P. (2020). *Middle school teachers' experiences implementing the workshop model in their classroom* (Publication No. 27963569) [Doctoral dissertation, Walden University]. ProQuest Dissertations and Theses Global.

Abstract: "Due to the increasing diversity in U.S. schools, there is a need for differentiated and individualized educational models for these learners to be successful in the future. However, little is known about innovative educational models allowing differentiation and individualized

education. The purpose of this basic qualitative study was to understand the experiences and perceptions of middle school teachers implementing the innovative Workshop Model (WSM) of teaching and learning. The conceptual framework for this study included the diffusion of innovation, sociocultural, and andragogical theories, and the principles of technological pedagogical content knowledge (TPACK). The participants were 10 middle school teachers recruited online with 3 years or more experience implementing the WSM in their classrooms. The data collected for this study included semi-structured phone interviews. Thematic inductive analysis of the interviews was used to identify themes. Results indicated that (a) teachers described the need to be flexible in their classroom to successfully implement WSM; (b) teachers were motivated to implement the WSM because their students were learning; (c) significant concerns impairing the implementation were the result of issues from outside their classroom; and (d) the teachers responded to substantial technology integration challenges including the lack of training, and access to hardware and software. The results of this study provide administrators and teachers new understanding on how the implementation of an innovative instructional model can support the goal of educating knowledge workers for the 21st century workforce in the U.S."

Schmidt, N. (2020). *Teaching digital literacies: Knowledges, practices, and resources in second language writing* (Publication No. 27999107) [Doctoral dissertation, University of Arizona]. ProQuest Dissertations and Theses Global.

Abstract: "Especially in the university second language writing (SLW) classroom, teachers face increasing demands to incorporate digital multimodal tools, yet there is limited scholarship focused on supporting SLW teachers who endeavor to do so. This suggests a need for technology-oriented professional development which fosters SLW teacher knowledge and supports the practical and critical application of digital tools in the language classroom (Anderson, Atkins, Ball, Millar, Selfe, & Selfe, 2006). The Technological, Pedagogical, and Content Knowledge (TPACK) theory, developed by Mishra and Koehler (2005, 2006), provides an integrated, contextually situated, empirically developed model which represents core knowledge bases requisite to teaching with technology (Voogt, Fisser, Pareja Roblin, Tondeur, & van Braak, 2013). TPACK, which is aligned with the principles of language teacher cognition (LTC) (Borg, 2006) and social constructivism (Vygotsky, 1987), attends not only to the core constructs of language teacher knowledge (content, pedagogy, and technology) but to all possible interactions between them. Furthermore, Hinrichsen and Coombs' (2014) framework of critical digital literacy offers a roadmap for integrating technology into the curriculum. The three studies of this dissertation extend the existing scholarship on language teacher knowledge and critical digital literacy in the SLW curriculum. Employing a grounded theory approach, semi-structured interviews, classroom observations, teacher reflections, instructional artefacts, and textbook content were analyzed. Through a multiple case study, conducted during a digital reflective portfolio module, Article one explored existing SLW teacher knowledge. Article two investigated how teacher knowledge developed in response to a corpus-based pedagogy professional development initiative. Finally, Article three analyzed the construction of technology-focused discourses in a popular university composition textbook.Taken together, the findings from these three studies suggest that SLW teacher

cognition is a complex and emergent system and that, despite an emphasis on digital literacy as a social and critical praxis in current literacy education scholarship, technology is presented in a predominantly functional, rather than critical, manner in a common university composition textbook. The implications of this research are twofold. First, teachers need ongoing, individualized support and training to develop not only their knowledge but also their confidence in using technology in the classroom. Also, the pitfalls of a functional approach to teaching digital composition could be circumvented by creating a composition textbook or other form of instructional materials which adhere to a critical digital literacies framework."

Swiger, S. L. (2020). *Technology use and integration by six sheltered instruction trained teachers* [Doctoral dissertation, The University of Akron]. OhioLINK. http://rave.ohiolink.edu/etdc/view?acc_num=akron158928744067648

Abstract: "This dissertation studied a selection of sheltered-instruction trained teachers' use of digital technology to teach content and language with native English speakers and English learners (ELs). This study used the TPACK framework and SAMR model as lenses to examine the teachers' skills, perceptions, and actions in using digital technology for classroom teaching and learning. Specifically, this study focused on the purposes for which these teachers use digital technology, the types of technology they use, their perceptions for how technology is used, and how it is applied to promote the components in the SIOP model. The study also examined the teachers' pedagogical approaches for technology integration through the lens of the SAMR model. This study was grounded in the concepts of the qualitative case research tradition. The primary research instruments employed included classroom observations and individual interviews of teacher participants. Six teacher participants were purposefully selected to examine the degree to which their technology use fit into the SAMR model and revealed their TPACK knowledge in technology integration. The six teacher participants were practicing teachers with training in the SIOP model and using technology in teaching content and language in classrooms with native English speakers and ELs. The analysis and presentation of these six individual case studies provided thorough descriptions of teaching and learning environments, including research site, ABSTRACT iv technology facilities support, and classroom technology availabilities. Moreover, the present study investigated teacher participants' different perspectives in technology use in teaching and their pedagogical practices in addition to their level for integrating technology into their classroom instructions. Findings indicated that the teacher participants' confidence and capability in using technology in the classroom were minimal in comparison with the other concerns expressed. For example, the inadequate access to digital devices was the major complaint from teacher participants who were teaching in urban school districts. Another finding from the present study is that most teacher participants did not have a clear vision of technology integration. To be specific, teacher participants understand pedagogical practice is the driving force that leads to effective teaching and learning. However, their vision disconnected with their actions in practices. Based on digital tools evaluated by using the SAMR model, results indicate teacher participants falsely believed they were integrating technology when in fact they were only supplementing conventional instruction with technology by spending more time in making the instruction appear technologically functional. Furthermore, for the most part, challenges for ELs in technology use

was not a great concern according to the teacher participants' responses. However, technology use does set high standards for ESL students who have insufficient technological skills; for example, students who recently came to the U.S. or came from countries with less access to digital technologies were at a disadvantage. Moreover, findings indicated that teacher participants might lack knowledge in using technologies to support language development along with the content delivery. They had strong knowledge in pedagogy of content and language, but they were weak when selecting v appropriate technologies to integrate within instructional plans for both content and language delivery. Techniques in sheltered instruction appeared to be often overlooked in technology selections to meet ELs' needs. Finally, the results from the present study revealed that the majority of teacher participants often used technology at the substation level followed by the augmentation level, indicating that the majority of the teacher participants did not use the available technology tools to their full potential. The present research study advances an understanding of the status of technological availability in public schools with EL populations and teachers' perceptions of technology integration. In addition, examining in-service teachers' technology integration effectiveness in instructional practices, particularly in sheltered instructional classrooms, will assist school districts in developing appropriate professional development that addresses teachers' needs by improving their knowledge in instructional technologies specifically for EL student. Keywords: English learners (ELs); digital technology; Substitution, Augmentation, Modification, and Redefinition model (SAMR); Technology, Pedagogy, and Content Knowledge (TPACK) model; Sheltered Instructional Observation Protocol (SIOP) model."

Tiede, J. (2020). *Media-related educational competencies of German and US preservice teachers: A comparative analysis of competency models, measurements and practices of advancement* [Doctoral dissertation, Universität Würzburg]. Media Education (MedienPädagogik). https://www.medienpaed.com/issue/view/84

Abstract: "Media have become omnipresent in children's and youths' everyday lives, and they also offer rich chances and challenges for educational contexts. On the one hand, media can, for example, support students' learning effectively, enhance lessons with innovative tools and methods and help individualize teaching and learning processes. On the other hand, students need to learn, e.g., how to use these media, how to select and evaluate them and how to act responsibly in a digitalized and mediatized world. Teachers are a core stakeholder in this context. To take advantage of the benefits media offer for teaching and learning processes, to support students in the acquisition of respective competencies and to fulfill numerous other media-related tasks and challenges, teachers need to acquire respective competencies in their initial teacher education, which can be summarized as media-related educational competencies.

The relevance of these competencies is evident on different levels. In related research, respective competency models are developed, and in practices of teacher education, competencies are measured and efforts are taken to advance the competencies of preservice teachers. Against this background, this semi-cumulative dissertation presents a theory-based and empirical analysis of the competencies in question from a comprehensive and

multidimensional perspective. In accordance with the central aspects outlined, the three systematic main fields focused on are models of media-related educational competencies, their measurement and practices of advancement in teacher education, as well as the interplay of these three fields. The dissertation takes on an international comparative perspective and focuses on the examples of initial teacher education in Germany and the USA.

The article-based dissertation comprises three main parts, framed by introduction and conclusion. The introduction provides a basis for the following work with regards to terminology, scope of research and overall methodology. The first main part is concerned with models of media-related educational competencies and includes a theory-based systematic comparison of three relevant models. This part explicates the varieties between competency models, and it discusses central aspects of selection and application. In Part II, methods and varieties of competency measurement are focused on, and an article is presented which shares results of an exploratory quantitative measurement of the respective competencies of German and US preservice teachers. Overall, this part reveals the potential and limitations of competency measurement and transfers these conclusions to the competency models introduced in Part I. Part III is concerned with an analysis of current practices of advancing media-related educational competencies in Germany and the USA. In this context, stakeholders influencing these practices will be systemized and analyzed in their role and impact. The article included in Part III introduces interviews which were conducted to achieve insights into the perspectives of selected experts, regarding relevant models, practices and outcomes of media-related teacher education in Germany and the USA.

Finally, the Conclusion of the dissertation will draw together the different strands, clarify the close connection between the domains of modeling, measuring and advancing the competencies in question and discuss the interdependencies of these three dimensions. These perspectives help both to contextualize and bring together important facets which have often been treated separately in related research and will add new facets to ultimately achieve a comprehensive and multifaceted viewpoint.

Against the background of the intercultural comparative perspective, the results and findings will ultimately achieve an enhanced and deep analysis and reflection on the complex field of media-related educational competencies in Germany and the USA and beyond."

Trevisan, O. (2019). *Student-teachers' pedagogical reasoning in technological pedagogical content knowledge design tasks: A cross-country multiple case study in initial teacher education institutions* [Doctoral dissertation, Università degli Studi di Padova]. Padova Digital University Archive. http://paduaresearch.cab.unipd.it/12362/

Abstract: "Teachers' professional expertise is based on (but not limited to) a complex, multifaceted and situated professional knowledge, in this dissertation identified in the Technological Pedagogical Content Knowledge (TPCK) framework. Literature has widely investigated the interconnections between TPCK and tacit non-rational underpinnings - in this dissertation identified in the construct of dispositions - when it comes to integrating

technologies into teaching practices. Furthermore, a successful technology integration, supported by strong knowledge bases and positive dispositions, implies specific decision-making processes to be enacted - in this dissertation identified in the construct of pedagogical reasoning. Hence, it is crucial to investigate how teachers reason professionally about integrating technologies, e.g. in a core teaching practice such as designing a learning unit. Whereas quite broad is the literature on the efficacy of engaging student-teachers in design tasks supporting dispositions and TPCK's improvement, it is still unclear if and how these tasks can engage some sort of pedagogical reasoning. The present dissertation reports on a research carried out at pre-service level to investigate how TPCK-informed design tasks may engage student-teachers in pedagogical reasoning, considering their implicit dispositions on the matter of technology integration in education. The ultimate aim of the research is to provide empirical evidence for a better understanding and fostering of reasoned technology-integrated teaching practices, to the service of initial education programmes, scholars and practitioners.

Given the complexity of the phenomenon and the contextual influence on it (i.e. the specific pre-service academic strategies used), this research takes the form of a multiple case study engaging three Higher Education institutions across Europe, in their Initial Teacher Education (ITE) programmes (N=345). The multiple case study included the implementation of several instruments for data collection, namely (1) observation, (2) documentation, (3) focused interviews and (4) a pre-/post - questionnaire. The reader will find both case-specific and cross-case analyses of the phenomenon at study.

Overall, the emerging findings would suggest ITE's strategies fair efficacy in supporting student-teachers' knowledge bases and dispositions toward technology integration, both powerful and positive enablers for future behaviours. On the other hand, notwithstanding the case-specific strengths, findings suggest that part of the student-teachers' reasoning processes for technology integration in design tasks, may find its roots elsewhere. The conclusions of the present research would suggest the need for further investigation of the phenomenon."

Wang, J. G. H. (2020). *Developing teachers technological, pedagogical, and content knowledge (TPaCK) through design thinking and community of practice* (sic) (Publication No. 27993669) [Doctoral dissertation, San Jose State University]. ProQuest Dissertations and Theses Global.

Abstract: "Current professional development programs have been ineffective in developing teachers' technological, pedagogical, and content knowledge (TPaCK). Development of teachers' TPaCK is fundamental for 21st-century student-learning. After a series of professional development workshops with the design thinking process, this study examined whether and how the self-selected K-5 teachers in a suburban elementary school in California demonstrated TPaCK in the integration of instructional technologies when they engage in a community of practice (CoP) structured around design thinking. Data was collected by online TPaCK surveys, exit slips after the CoP, audio recordings and field notes from the CoP and focus group interview. This study examined evidence of growth in teachers' TPaCK and the teachers' attitudes and perceptions of the process and outcomes of going through the design thinking method and a CoP."

Wasilko, A. T. (2020). *An investigation of technology implementation through the lens of student centered learning and the technological pedagogical content knowledge paradigm* (Publication No. 27737935) [Doctoral dissertation, Duquesne University]. ProQuest Dissertations and Theses Global.

Abstract: "National statistics show that there are increases in access and availability of computers, and technology, in both the classroom and students' personal lives (Culp et al. 2005, Hoffman & Ramirez, 2018). However, Tas (2017) and Wachira and Kenngwee (2010) posit that there is stagnation, even declines in certain cases, of the integration of instructional technologies in delivering student center learning in the classroom. This decline is even more prevalent in the science classroom (Vickrey, Golick, & Stains, 2018). Teachers face many challenges in the classroom; especially when technology integration is considered (Blackburn, 2016). This study seeks to determine which conditions exist to create this decline and stagnation and offer practical solutions to overcome them. A qualitative study was implemented to determine what training educators receive to deliver science content using technology, and also examine what activities and tools are being used in the secondary science classroom. The greater Pittsburgh and Allegheny County educational district was selected for this study. Results were examined through the lens of the Technological Pedagogical and Content Knowledge (TPACK) paradigm and Substitution Augmentation Modification Redefinition (SAMR) model, with focus on student centered learning (SCL) activities. An initial survey was completed by 51 teachers, and six teachers were selected for follow up interviews as a part of this study. Those teachers represent both high and low implementers of technology in their classroom, based on their self-reported used of technology. Technology was found to be used on a daily basis on each of these classrooms, however, it was found that no pedagogical training was given to any of the teachers before implementing new technology. True TPACK was only found in two teachers, with daily use of SCL being found in each classroom. No correlation was suggested by increased SCL activities and TPACK, as teachers were employing many SCL activities without TPACK. Only two of the teachers studied offered tasks on the higher levels of SAMR, modification and redefinition. Three major themes emerged from this study: 1) positive views of technology with no pedagogical training, 2) favorable views of SCL with daily classroom integration, 3) and lack of district or administrative support. Barriers were found in three categories of SCL: pragmatic, pedagogical, and technological. This study shows that teachers want to use technology, and see it as valued tool. It was discovered that teachers are not being given the tools they need to created technology infused classrooms that represent true TPACK."

Weir, A. A. (2020). *Perceptions, potholes, and possibilities of using digital voice assistants to differentiate instruction* (Publication No. 27960870) [Doctoral dissertation, Walden University]. ProQuest Dissertations and Theses Global.

Abstract: "Access to technologies and understanding the potential uses of technology to differentiate instruction have been a concern for the teachers and students in a local school district located in the southeastern United States. Despite the emergence of digital voice assistants (DVAs) as tools for instructions, teachers lack knowledge and strategies for using

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DVAs to differentiate instruction in their classrooms. The purpose of this qualitative study was to identify teacher knowledge and strategies employed among special education (SPED) teachers using DVAs to differentiate instruction in their classrooms. The concepts of Carol Tomlinson's differentiation theory and Mishra and Koehler's TPACK framework served as the foundation of this study. The research questions examined middle school SPED teachers' perceptions of challenges using DVAs to differentiate instruction, resources, and strategies available to these teachers as well as their perceived knowledge of using DVAs to differentiate instruction. In this basic qualitative study, data were collected from 6 SPED teachers using semi-structured interviews. Interviews were recorded, transcribed, and analyzed thematically. The findings suggest that teachers had little to no perceived challenges when using DVAs to differentiate instructions. However, the overutilization of DVAs might rob students of their ability to think independently. This study offers several prospects for future research related to the topic and findings. Further research is needed at the elementary and high school levels that may include core content teachers. The findings in this study serve as grounds for social change for schools and school districts to develop training solutions, policies, and guidelines for teachers to follow when implementing technology."

5. Recommended Recent TPACK-related Blog Entry

Cycles of Learning Blog: Online Teaching Reflection: Day 29
Ramsey Musallam

"Today I find myself reflecting more philosophically on the distance learning process, specifically [models of technology integration](#). If you follow the work on this, two models, [SAMR](#) and [TPACK](#) talked about are referenced the most.

As shown above, SAMR is a more technology-centered" (in my opinion) approach that outlines how tools are used to on a spectrum of "Substitution" to "Redefinition". TPACK emerges from the work on [Pedagogical Content Knowledge (PCK)](#). Whereas PCK identifies overlap between the content a teacher will deliver and how they plan on delivering it, TPACK introduces technology as a third facet. The sweet spot being the overlap between the content a teacher will deliver, how they will deliver it, and the appropriate technological tool to empower the process." [Read more]

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 (7th edition) of the *Publication Manual of the American Psychological Association* suggests that the citation should look like this:

Harris, J., & Gallagher, E. (Eds.). (2021, March 31). *TPACK newsletter issue #44: March 2021*
[Electronic mailing list message]. http://bit.ly/TPACKNewslettersArchive

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

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

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

Standard End-Matter

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

- Judi & Evan

…for the SITE TPACK SIG leadership:

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