TPACK Newsletter, Issue #42: November 2019

Welcome to the 42nd 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 Technology
"Every once in a while, a new technology, an old problem, and a big idea turn into an innovation."
-Dean Kamen

In This Issue

1. TPACK Newsletter Update

The TPACK Newsletter has been published via the tpack.news email list since January 2009. It has 1215 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: 1170   Chapters: 291   Books: 28   Dissertations: 394

2. Recent TPACK Publications

Below are recent TPACK publications that we know about: **116 articles**, **5 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

Akuma, F. V., & Callaghan, R. (2019). A systematic review characterizing and clarifying intrinsic teaching challenges linked to inquiry-based practical work. *Journal of Research in Science Teaching*, *56*(5), 619–648. https://doi.org/10.1002/tea.21516

Abstract: "Since scientific literacy has become a key goal in science education, many people have argued in favor of the incorporation of inquiry in science education. However, scattered in the literature are extrinsic and intrinsic teaching challenges linked to the design and implementation of inquiry-based practical work (IBPW) in secondary school science classrooms. The purpose of this systematic literature review was to characterize and clarify the intrinsic challenges. From an instructional design perspective, the characterization of the challenges yielded four primary categories. The categories consist of initiation-phase challenges (such as unfavorable views regarding science and practical work), planning-phase challenges (including difficulties involved in designing IBPW), implementation-phase challenges (e.g., persuading learners to reflect on their experiences and findings), and summative evaluation-phase challenges which include concerns linked to the grading of practical inquiry. In the different categories, the challenges are linked to gaps in various aspects of teacher competencies especially in the context of the TPACK framework. The aspects include content knowledge (CK) (such as science content and scientific inquiry); in addition to technological knowledge (TK) linked to standard technologies. Also included is pedagogic CK (including orientation toward science teaching). Moreover, some of the intrinsic challenges are linked to gaps in skills (including pervasive classroom management and practical skills); in addition to values (such as commitment). These results have theory-, practice-, and research-based implications."

Al-Abdullatif, A. M. (2019). Auditing the TPACK confidence of pre-service teachers: The case of Saudi Arabia. *Education and Information Technologies*. Advance online publication. https://doi.org/10.1007/s10639-019-09924-0

Abstract: "This study has investigated the technological knowledge (TK) and technological pedagogical and content knowledge (TPACK) confidence of 113 Saudi pre-service teacher students who were in their final year of the teacher education program. For this purpose, a descriptive survey method was used, and the data was obtained using the TPACK Confidence Survey (TCS). The results indicated a high percentage of participants had a very low level of perceived competences while using digital technologies for teaching and learning. Similarly, participants expressed a very low level for most TPACK integration practices. Female pre-service teacher participants exhibited a more significant confidence and readiness to engage in

information and communication technology practices to transform learning outcomes of students. Several implications and recommendations are derived and discussed in this study."

Alemdag, E., Gul Cevikbas, S., & Baran, E. (2019). The design, implementation and evaluation of a professional development programme to support teachers' technology integration in a public education centre. *Studies in Continuing Education*. Advance online publication. https://doi.org/10.1080/0158037X.2019.1566119

Abstract: "The main purpose of this study was to design and implement a professional development programme on technology integration for teachers in a public education centre based on the technological pedagogical content knowledge (TPACK) framework and learning by design approach, and to evaluate the programme's impact. Ten adult education teachers in a public education centre participated in this case study research. Data sources include teacher-reflective reports, lesson plans and focus group interviews. The results revealed that the programme both enhanced teachers' TPACK and influenced their teaching practices. The results emphasise the importance of providing information that aligns with teachers' specific needs in adult education centres, giving teachers an active role, making opportunities available to design technology-enhanced learning artefacts while working in collaborative teams and selecting ICT tools based on typical adult learning characteristics. The study also offers suggestions for future research and practice on the design of professional development programmes."

Al-Gumaei, G. S., Alzouebi, K., & Abdelaziz, H. A. (2019). The Islamic studies teachers' perception of integrating ICT into the teaching and learning in the UAE public schools: Challenges, opportunities and practices. *International Journal of Technology Diffusion*, *10*(2), 69–82. https://doi.org/10.4018/ijtd.2019040104

Abstract: "This article investigates Islamic Studies teachers' perceptions in integrating ICT, and the anticipated challenges faced when using ICT. Data was collected through a questionnaire and semi-structured interviews. A total of 62 teachers participated in an online questionnaire consisted of 48 questions. In addition, eight teachers participated in the interviews. The findings of this study revealed positive perceptions of both male and female teachers in the integration of technology in their classrooms. The results showed that there were no significant differences between male and female teachers in all parts of the questionnaire. It also indicated that there was a number of challenges hindered the teachers' use of technology in teaching. Based on the research findings, it was recommended that stakeholders and decision makers in the MOE implement relevant training programs for Islamic studies teachers, to upgrade integrating ICT in classrooms. In addition, this article gives insights into future research studies on the effective use of ICT by Islamic studies teachers."

Alharbi, H. E. (2019). An Arabic assessment tool to measure technological pedagogical and content knowledge. *Computers & Education*. Advance online publication. https://doi.org/10.1016/j.compedu.2019.103650

Abstract: "Issues associated with classroom technology integration have become an interest of various educational research communities worldwide. To guide research into teachers' integration of technology, several important theoretical frameworks have emerged recently, one of which is the Technological, Pedagogical and Content Knowledge (TPACK) conceptual model. However, current research on methodological assessments adopting this model has indicated a need for developing a valid and reliable Arabic assessment for assessing Arabic-speaking secondary preservice teachers' TPACK. Therefore, an Arabic survey instrument was designed and administered to 350 secondary preservice teachers who were studying in a postgraduate teachers preparation program. The instrument includes 27 items and can be gathered under 7 factors representing the conceptual framework domains. Confirmatory factor analyses provided evidence that the designed Arabic instrument is a reliable and valid assessment for determining the TPACK of secondary preservice teachers in the context of the study location. Recommendations and implications have been given for future research and practices. • Limited valid instruments measuring secondary preservice teacher's TPACK exist. • An Arabic instrument was developed with 27 items in seven subscales of TPACK. • Confirmatory factor analysis was performed. • The Arabic TPACK instrument had good validity statistics on all constructs. • The reliability for each construct of the instrument was satisfactory."

Alvarez-Otero, J., & de Lazaro y Torres, M. L. (2018). Education in sustainable development goals using the spatial data infrastructures and the TPACK model. *Education Sciences*, *8*(4), 171. https://doi.org/10.3390/educsci8040171

Abstract: "Education in Sustainable Development Goals is a basic step in attaining its objectives, and, therefore, it has been undertaken by broad sectors of the teaching community. Nevertheless, the "sustainability curriculum" derived from the Sustainable Development Goals, in this case based on the data of the Spatial Data Infrastructures, in spite of its teaching and research potential, is something with which the teaching body is not yet familiar. The results of the fieldwork carried out (questionnaires and Delphi technique) prove this to be the case. For this reason, in order to educate geographically in reflection and collaboration with the aims of the Sustainable Development Goals, the viewing, in a GIS on the Cloud (WebGIS) of indicators of interest is proposed for the Sustainable Development Goals taken from the Spatial Data Infrastructures within the framework of the TPACK (Technological Pedagogical Content Knowledge) model. To facilitate all these learning objectives, a proposal for good practices in the classrooms of secondary schools and another proposal for university lectures have been designed, and the results applied and analyzed. These examples demonstrate empirically that, with adequate pedagogical tools, an education in geography for global understanding by integrating Sustainable Development Goals and Spatial Data Infrastructures can be achieved, which is what the TPACK model pursues."

Amhag, L., Hellstrom, L., & Stigmar, M. (2019). Teacher educators' use of digital tools and needs for digital competence in higher education. *Journal of Digital Learning in Teacher Education*, *35*(4), 203–220. https://doi.org/10.1080/21532974.2019.1646169

Abstract: "Based on a study at two Swedish universities, this article aimed to identify teacher educators' use of digital tools and subsequent need for digital competence in higher education. Methodically, a digital survey was distributed via e-mail to 405 teacher educators representing two faculties at the two universities; in total, 105 teacher educators responded. The survey included 16 questions, with closed- and open-ended varieties. Two theoretical foundations were used: the TPACK model and, as a complement, computer self-efficacy. Through analysis of self-reported use, competence, and need for professional training in digitalization in teaching, results show that teacher educators do not use digital tools primarily for pedagogical purposes. Thus, they need extensive pedagogical support in creating digital teaching. Further, teacher educators need to identify the pedagogical surplus value in their own teaching and learning context with digital tools to increase motivation for concrete, effective, and subject-oriented successful examples as presented by experienced teachers."

Anandh, S. P., & Uthamacholapuram, S. (2019). Developing knowledge and skills on traditional games among teacher trainees (an empirical study). *Cikitusi Journal for Multidisciplinary Research*, *6*(6), 263–269. Retrieved from http://www.cikitusi.com/gallery/34-june-894.pdf

Abstract: "An empirical study was conducted to develop knowledge and skills on traditional games among teacher trainees. The investigator conducted a single group experimental study. He constructed a self-made tool to measure the initial knowledge of knowledge and skills on traditional games through pretest. There are 25 days training programme was organized to develop the develop knowledge and skills on traditional games among teacher trainees. The investigator prepared a module to teach the selected 25 games. The action hypothesis of the study is; the pre service teacher trainees will be developed their knowledge and skill of playing selected traditional games. Only percentage analysis was used to find out the level of knowledge and skills on traditional games among teacher trainees. The major findings of the study are The maximum game known by the pre service teacher trainees in the pretest 8 had increased to 24 games in the post test; The minimum game known by the pre service teacher trainees inthe pretest 5 had increased to 23 games in the post test; The mean score of the game known by the pre service teacher trainees in the pretest 6had increased to 22 in the post test. Educational implication of the study are: In the primary school settings there are no ground, no play material and no physical education teacher to teach physical education programme. In this juncture the pre service teacher trainees are trained the procedure to play the traditional game, in turn when they become the in-service teacher they teach traditional game. They make the children to be joy and delight, develop thinking skill, and develop social values and to enforce our tradition, culture and heritage to the next generation."

Antony, M. K., & Paidi. (2019). TPACK observation instrument: Development, validation, and reliability. *Journal of Physics: Conference Series*, *1241*(1). https://doi.org/10.1088/1742-6596/1241/1/012029

Abstract: "The aims of this study is to develop an observation instrument and test the validity and reliability used to measure the performance of biology teachers to apply TPACK in the

learning process. This research is included in the DDR. The steps to develop TPACK observation instruments are, (1) analysis of products to be developed; (2) initial product development; (3) product validation; (4) field trials; and (5) product revisions. TPACK observation instrument was trialed on 11 biology teachers in two provinces, Yogyakarta and Central Java in August 2018, involving 4 rater. Face validity and empirical validity were carried out. Instrument face validity involves 2 expert judgements and empirical validity is determined by looking for Biserial Correlation value. Intraclass correlation coefficient (ICC) is used to test reliability. Empirical validity based on the value of Biserial Correlation shows that all items are valid with R count> 0.602. The reliability value of the TPACK instrument disclosed by the ICC is 1,000, which means that the instrument has a high reliability level. In addition, the development of both reliable and valid scale related to the technological pedagogical content knowledge of biology teachers' would be promote further studies."

Astuti, F. E. C., & Paidi (2019). Developing an observation instrument to measure technological pedagogical knowledge (TPK) of biology teacher in learning process. *Journal of Physics: Conference Series*, *1241*(1). https://doi.org/10.1088/1742-6596/1241/1/012053

Abstract: "Technological Pedagogical Knowledge (TPK) was a knowledge that must be mastered by the teacher for measuring a suitable technology for supporting the strategic application of teaching. TPK was important to be studied because it was the most influencing aspect for teacher's TPACK. Basically, there was no observation instrument that discovers the TPK of biology teacher. The aim of this research was to develop an observation instrument for measuring TPK of biology teacher in learning process. The method used is design and development research (DDR) by Richey and Klein model. The instrument framework was developed based on educational standard for teacher in Indonesia, and then it was used to develop the items. Instrument will be tested for face validity by evaluation and education experts. Instruments that pass the face validity check were tried out on 11 teachers from six schools in DIY and Central Java region. The result showed that 11 items pass the empirical validity based on point biserial correlation and interater reliability was 0.968 based on intraclass correlation coefficient (ICC) - that means all items in the category were reliable. Thus, the observation instrument is qualified to measure the TPK of biology teacher in learning process."

Atun, H., & Esta, E. (2019). The effects of programming education planned with TPACK framework on learning outcomes. *Participatory Education Research*, *6*(2), 26–36. https://doi.org/10.17275/per.19.10.6.2

Abstract: "This study aims at investigating the effects of programming education planned with TPACK (Technological Pedagogical Content Knowledge) Framework on middle school students' learning outputs within the ITS (Informational Technology and Software) course. Although TPACK is known as a teacher training program, this study demonstrates it can be used in K12 education. The sample of the research consists of 41 6th grade level students from a Turkish middle school. This study used a quasi-experimental research design which compares pre-test and post-test results for experimental and control groups. Data were collected through quantitative scales. The effects of programming education planned with TPACK framework on

students' academic achievement, perception of problem-solving skills and computational thinking skills are investigated. According to the results, the means of academic achievement, problem solving inventory and computational thinking skill scale scores of the experimental group are significantly higher, which means TPACK framed lesson has a positive impact on learning outcomes. As a result of this study it can be concluded that matching technology that is suitable for the relevant content is crucial for learning, using appropriate technology is a good strategy for learning technology, higher order skills are improved by technology supported learning and academic achievement can be enhanced by using enriched activities in a technological environment."

Bahriah, E. S., & Yunita, L. (2019). Investigating the competencies of technological pedagogical content knowledge and self-efficacy of chemistry teachers. *Journal of Physics: Conference Series*, *1233*(1). https://doi.org/10.1088/1742-6596/1233/1/012021

Abstract: "Technological Pedagogical Content Knowledge (TPACK) is an integration knowledge between technology, content of learning, and pedagogy which obtain to an integrated learning based on computer technology. Moreover, the pre-service teachers have a strengthen competencies of teachers integrating to knowledge, pedagogic, and technology. This research is aimed to investigate the Technological Pedagogical Content Knowledge competencies related to self-efficacy of chemistry teachers in Serang regency, Banten, Indonesia. Furthermore, the writers use a descriptive analysis as the research methodology. The sample of this research involves sixty-one chemistry teachers in the Senior High School level located at Serang city and Serang regency. To analyze the data, the writers provide a Likert scale. The result showed that the TPACK competencies scores in both Serang city and Serang regency raise up to 76.2 and 77.9 representatively. Whereas, the self-efficacy score in the two regions proved into 77.0 and 79.1 chronologically. Based on the data showed, it can be concluded that the relationship between TPACK and self-efficacy cannot be separated one another. Therefore, the Technological Pedagogical Content Knowledge (TPACK) and self-efficacy of the chemistry teachers are comparable to the competencies of the Chemistry teachers."

Bardakci, S., & Alkan, M. F. (2019). Investigation of Turkish preservice teachers' intentions to use IWB in terms of technological and pedagogical aspects. *Education & Information Technologies*, *24*(5), 2887–2907. https://doi.org/10.1007/s10639-019-09904-4

Abstract: "The purpose of this study was to investigate the technological and pedagogical constructs underlying Turkish preservice teachers' behavioral intentions to use interactive whiteboard based on UTAUT model and TPACK using three structural equation models; technological framework, pedagogical framework, and integrated model. Within this scope, preservice teachers' behavioral intentions to use IWB was defined as the dependent variable. Performance expectancy, effort expectancy, IWB self-efficacy, and technological knowledge were technological independent variables while individual innovativeness, technological pedagogical knowledge, pedagogical knowledge, and constructive and traditional teaching beliefs were pedagogical independent variables. Nine hypotheses were formulated based on the causal relationships between behavioral intentions to use IWB and independent variables.

The proposed model was tested through SEM based on maximum likelihood estimation method using LISREL v.8.71 software. The significance of X2, the ratio of X2/df and other goodness of fit indices were used in the evaluation of the models' fit. For hypothesis tests, path coefficients (β) and t values for each hypothesis were used. The findings showed that performance expectancy and technological pedagogical knowledge were the variables that significantly influenced the behavioral intention to use IWB in technological and pedagogical frameworks, respectively. Moreover, performance expectancy was the sole variable that significantly and positively influenced the preservice teachers' behavioral intentions to use IWB in the integrated model. The main conclusion of this study was the revelation of teachers' beliefs that IWB use would help them be better teachers by improving their performance independent from all other variables examined in the study."

Bingimlas, K. (2018). Investigating the level of teachers' knowledge in technology, pedagogy, and content (TPACK) in Saudi Arabia. *South Africa Journal of Education*, *38*(3), 1–12. https://doi.org/10.15700/saje.v38n3a1496

Abstract: "This self-assessment study aims to investigate Saudi teachers' knowledge about the three essential components of TPACK, technology, content, and pedagogy. A quantitative research design was employed. The sample included 111 males and 132 females; out of which, 116 were primary grade teachers, 55 were middle grade teachers, and 72 were secondary grade teachers. Around 32% of the teachers had teaching experienceofbetween10 and20 years, and about 27% had teaching experience of between5 and10 years. A majority of the teachers reported that they had an average confidence level of knowledge relative to the TPACK framework. Certain differences existed amongst them on the basis of their gender, teaching subjects, and teaching experience. Statistically, a significant difference was shown between technological content knowledge and teaching experience. A recommendation resulting from the study was that the teachers ought to change their teaching style from traditional to effective learning approaches with the use of technology. Beyond this, the Ministry of Education ought to focus on providing both girls' and boys' schools with educational technologies, and teachers with effective technological training."

Bohloko, M., Makatjane, T. J., George, M. J., & Mokuku, T. Assessing the effectiveness of using YouTube videos in teaching the chemistry of group I and VII elements in a high school in Lesotho. *African Journal of Research in Mathematics, Science & Technology Education*, *23*(1), 75–85. https://doi.org/10.1080/18117295.2019.1593610

Abstract: "This study, based on the theory of Technological Pedagogical Content Knowledge investigated the effectiveness of introducing open source YouTube videos in the teaching and learning of the Chemistry topic 'Group Properties' at a high school in Lesotho. A quasi-experimental design was used for two conveniently selected Form D classes; one class used as the experimental group (n = 49) and the other as a control group (n = 60). The questions in the pre-test and the similar post-test were formulated to establish the learners' cognitive abilities in line with various levels of Bloom's Cognitive Domain. The mean performance of the two groups before the intervention was not statistically different. After introducing the

experimental group to YouTube videos, the performance of the group was significantly better than that of the control group during the post-test. The performance of the experimental group was also significantly better than that of the control group at the higher cognitive levels of Bloom's Cognitive Domain, namely, at application to evaluation. The incorporation of videos in teaching Chemistry provided a better option than the traditional method of science teaching. The use of the YouTube videos resulted in a doubling of the percentage of the experimental group learners passing the post-test (from 12 to 27%), while the percentage of control group learners passing the tests remained constant at 5% for both the pre-test and the post-test. In light of the significant benefits of using YouTube videos in this context of poor laboratory resources, it is recommended that teachers should be trained to integrate technology in their teaching in order to supplement practical work."

Bora, A., & Ahmed, S. (2019). An investigation on mathematics teachers' technological pedagogical content knowledge (TPACK) in secondary school setting in Assam. *International Journal of Technical Innovation in Modern Engineering & Science*, *5*(5), 530–536. Retrieved from http://www.ijtimes.com/papers/finished_papers/IJTIMESV05I05150509222940.pdf

Abstract: "The theoretical structure of Technological Pedagogical Content Knowledge (TPACK) plays an increasingly important role in the restructuring of teaching learning process both in our country and in the world. The TPACK system tries to help the advancement of better strategies for finding and portraying how technology related proficient learning is actualized and manifested practically (Matthew et al., 2013). As research in TPACK becomes more empirical, it becomes more important that researchers scrutinize the measurement properties of TPACK instruments. The critical issue of "does my instrument accurately capture my participants' levels of understanding in TPACK?" needs to be addressed first as it is essential for good research (Kelly, 2010; Koehler et al., 2011). Researchers who develop TPACK survey instruments, however, have devoted attention to the reliability and validity properties of TPACK measurement. Specifically, TPACK survey research has allowed researchers to further address the issues like –internal consistency, test–retest reliability, and discriminant and convergent validity about the measurement of TPACK. In this research, the examination concentrated on Mathematics Teachers' Technological Pedagogical Content Knowledge (TPACK) for utilizing ICT in educating and learning successfully in secondary schools. This examination was completed with 45 mathematics educators serving in 38 secondary schools situated in a hilly region of Assam. The sample survey method was adopted for the present investigation. A research instrument was developed to measure Mathematics Teachers' Technological Pedagogical Content Knowledge (TPACK) for utilizing technology in teaching-learning process. Gathered information was examined through various statistical tools. The information was investigated dependent on 7 distinctive learning premise characterized in TPACK structure."

Bostancıoğlu, A., & Handley, Z. Developing and validating a questionnaire for evaluating the EFL "Total PACKage:" Technological pedagogical content knowledge (TPACK) for English as a Foreign Language (EFL). *Computer Assisted Language Learning*, *31*(5/6), 572–598. https://doi.org/10.1080/09588221.2017.1422524

Abstract: "This paper introduces a new self-report questionnaire for the assessment of TPACK for English language teaching which does not prescribe a particular approach to language teaching or the use of particular technologies. Development and validation of the questionnaire involved: (1) creation of an initial item pool based on a review of the literature on Pedagogical Content Knowledge (PCK) and the use of technology in EFL, (2) evaluation of the content validity of the initial items with a panel of 36 international experts in computer-assisted language learning, (3) exploration and validation of the underlying factor structure through the administration of the questionnaire to 542 EFL practitioners and Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). A six-factor solution, comprising PCK, TK, CK, Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), and Technological Pedagogical Content Knowledge (TPCK), emerged from the EFA and was subsequently confirmed through CFA. The results provide support for approaches to English language teacher education which attempt to integrate TK, PK, and CK, rather than introduce them separately, and which highlight the ways in which emerging and established technologies can be employed to represent language and provide opportunities for communication that are known to promote language acquisition."

Bull, G., Hodges, C., Mouza, C., Kinshuk, G. M., Archambault, L., Borup, J., Ferdig, R. E., & Schmidt-Crawford, D. A. (2019). Conceptual dilution. *Contemporary Issues in Technology and Teacher Education*, *19*(2). Retrieved from https://www.citejournal.org/volume-19/issue-2-19/editorial/editorial-conceptual-dilution

Abstract: none (editorial)

Bustamante, C. (2019). TPACK-based professional development on web 2.0 for Spanish teachers: A case study. *Computer Assisted Language Learning*. Advance online publication. https://doi.org/10.1080/09588221.2018.1564333

Abstract: "The topic of this study is professional development (PD) on Web 2.0 technologies for foreign language teachers and integration of these tools into the language classroom. This research explored the experiences of eighteen teachers of Spanish in grades 7-12 from both rural and urban areas in Nebraska, United States, who participated in a technology, pedagogy, and content-based online PD. This qualitative case study included data from interviews, classroom observations, and documents to explore the learning and integration journeys of Spanish teacher participants during and after the PD. While qualitative findings indicated mainly positive learning experiences in the three areas -technology, pedagogy, and content- as well as in technology integration, the observational data illuminated issues of technology access and use of the target language (TL) by the teachers. The article concludes with implications for the design of PD on technology for foreign language teachers."

Cai, W., Wen, X., Cai, K., & Lv, Z. (2019). Measure and improvement path of TPACK context of professional teachers of civil engineering in higher education. *Revista de Cercetare si Interventie Sociala*, *65*, 276–291. https://doi.org/10.33788/rcis.65.17

Abstract: "In the information age, with the rapid emergence of multimedia computers, smart phones and various Web-based RIA applications and AR and VR technologies, the information and intelligence of the education and teaching environment has continuously enhanced. The innovation of teacher training mode and the development of teacher professionalization should be achieved by continuously improving the teacher's knowledge structure and promoting the integration of technology and teaching. To study how to construct and continuously improve the new teacher knowledge structure system integrating information technology, it will become the basic part of the innovative teacher-training model and the professional development of teachers in the new era. The college civil engineering professional education has been developing with the development of the national social economy; the demand for talents has continuously increased. In addition, the innovation of civil engineering professional teaching is in urgent need of development. It is necessary to improve the quality of the teaching team. It is imperative to study the TPACK level of civil engineering teachers. Based on this, this paper builds a dedicated test scale and retains 34 items after screening. 180 data results were obtained, through the collection of questionnaires. Then we use SPSS statistical analysis software to conduct project analysis on the test results to verify the relevance and reliability of the test items in the test scale. Then, we determine the structural validity of the test scale by factor analysis of the test results. Finally, we analyzed the factors affecting the TPACK context based on the resulting data. The results show that the national policy school environment is a macro factor that affects TPACK, and the teacher's self-efficacy is a micro factor. Based on this, we have proposed different development plans from different angles."

Cam, E., & Saltan, F. (2019). The relationship between primary education teachers' technological pedagogical content knowledge and lifelong learning tendency. *Ilkogretim Online*, *18*(3), 1196–1207. https://doi.org/10.17051/ilkonline.2019.611468

Abstract: "The aim of this study is to determine the relationship between primary education teachers' technological pedagogical content knowledge and lifelong learning tendency. In the study, the survey method, one of the qualitative research methods, was used. 357 primary education teachers in Muş, Bulanık participated in this study. The data was collected with "Technological Pedagogical Content Knowledge Scale" developed by Schmidt and others (2009) and adapted to Turkish by Öztürk and Horzum (2011), and with "Lifelong Learning Tendency Scale" developed by Coşkun (2009). According to the research results, the Technological Pedagogical Content Knowledge does not show a meaningful difference according to gender and accommodation unit while it shows a meaningful difference according to branch and school levels. As for the lifelong learning tendency, it does not indicate a meaningful difference according to gender, branch, accommodation unit, and school level. However, a low rate significant relation between the Technological Pedagogical Content Knowledge and lifelong learning tendency was found."

Cardullo, V. M., & Clark, L. (2019). Exploring faculty and student iPad integration in higher education. *International Journal of Reliable and Quality E-Healthcare*, *8*(2), 50–69. https://doi.org/10.4018/ijrqeh.2019040104

Abstract: "Higher education institutions are exploring the impact of technology integration in educational settings since the release of marketed devices like the iPad and Chromebook. A university in the southern region of the United States launched a yearlong feasibility study to explore how mobile technologies support student learning, influence instruction, and identify how faculty and students perceive the usage of mobile devices for teaching and learning. The population consisted of freshman-level participants enrolled in a general education biology course. Student participants ranged from 17-21 years of age. All students were provided with an iPad to use during the year. Researchers used several data sources to collect bi-weekly observations on both faculty and students, a student survey, and post focus group interviews with students and faculty. Using the SAMR model paired with Bloom's taxonomies, findings described the various levels in which iPads were integrated into instruction by faculty and student participants. Research revealed student appreciation of iPad affordances and features of the device. The analysis also identified building infrastructure, technology support, and teacher training in technology integration as vital pieces to a successful schoolwide implementation."

Cekmez, E., & Guler, M. (2019). One problem, multiple solutions: The contribution of DGS to heuristics in the problem-solving process. *Journal of Computers in Mathematics and Science Teaching*, *38*(3), 231–247. Retrieved from https://www.learntechlib.org/p/184718/

Abstract: "There is a large body of literature concerning the potential of dynamic geometry software (DGS) in the problem solving process. However, questions regarding how teaching should take place to prepare students to use DGS as a heuristic tool in non-routine problem situations seem to be overlooked. To address this gap in the literature, the current study aimed to investigate a teaching sequence designed to develop prospective mathematics teachers' competence to use DGS as a heuristic tool in investigating non-routine geometry problems. To assess the effectiveness of the approach adopted in the study, a homework assignment was used as a data collection tool following a five-week teaching sequence. The students provided three different authentic solutions, all of which exemplified how DGS can contribute to the development of students' problem-solving skills and support various problem-solving techniques. The study presents the analysis of the students' solutions, as well as the content of the teaching sequence."

Chai, C. S. (2019). Teacher professional development for science, technology, engineering and mathematics (STEM) education: A review from the perspectives of technological pedagogical content (TPACK). *Asia-Pacific Education Researcher*, *28*(1), 5–13. https://doi.org/10.1007/s40299-018-0400-7

Abstract: "This review identifies 20 studies pertaining to teacher professional development for STEM education. Using a mixture of content analysis with reference to the TPACK framework, and open and axial coding, a descriptive model was constructed. The model describes the connection of the various categories of variables associated with teacher professional

development for STEM. How content, pedagogy, and technology are featured in current STEM research are treated as properties of the core phenomenon of teacher professional development for STEM. Design considerations for future research are presented. The study recommends that design thinking, epistemic fluency and technological pedagogical engineering knowledge could be the anchors of future research."

Cheung, G., Wan, K., & Chan, K. (2018). Efficient use of clickers: A mixed-method inquiry with university teachers. *Education Sciences*, *8*(1), 31. https://doi.org/10.3390/educsci8010031

Abstract: "With the advancement of information technology and policies encouraging interactivities in teaching and learning, the use of students' response system (SRS), commonly known as clickers, has experienced substantial growth in recent years. The reported effectiveness of SRS has varied. Based on the framework of technological-pedagogical-content knowledge (TPACK), the current study attempted to explore the disparity in efficiency of adopting SRS. A concurrent mixed method design was adopted to delineate factors conducive to efficient adoption of SRS through closed-ended survey responses and qualitative data. Participants were purposefully sampled from diverse academic disciplines and backgrounds. Seventeen teachers from various disciplines (i.e., tourism management, business, health sciences, applied sciences, engineering, and social sciences) at the Hong Kong Polytechnic University formed a teacher focus group for the current study. In the facilitated focus group, issues relating to efficient use of clickers, participants explored questions on teachers' knowledge on various technologies, knowledge relating to their subject matters, methods and processes of teaching, as well as how to integrate all knowledge into their teaching. The TPACK model was adopted to guide the discussions. Emergent themes from the discussions were extracted using NVivo 10 for Windows and were categorized according to the framework of TPACK. The survey, implemented on an online survey platform, solicited participants on teachers' knowledge and technology acceptance. The close-ended survey comprised 30 items based on the Technological Pedagogical Content Knowledge (TPACK) framework and 20 items based on the Unified Theory of Acceptance and Use of Technology (UTAUT). Participating teachers concurred with the suggestion that use of clickers is instrumental in engaging students in learning and assessing formative students' progress. Converging with the survey results, several major themes contributing to the successful implementation of clickers, namely technology, technological-pedagogical, technological-content, technological-pedagogical-content knowledge, were identified from the teacher focus groups. The most and second most frequently cited themes were technological-pedagogical-content Knowledge and the technological knowledge respectively. Findings from the current study triangulated with previous findings on TPACK and use of clickers, particularly, the influence of technological-pedagogical-content Knowledge and technological knowledge on successful integration of innovations in class. Furthermore, the current study highlighted the impact of technological-pedagogical and technological-content knowledge for further research to unfold technology adoption with these featured TPACK configurations, as well as rendering support to frontline academics related to integration of technology and pedagogy."

Chukwuemeka, E. J., Nsofor, C. C., Falode, O. C., & Aniah, A. (2019). Assessing pre-service teachers' technological pedagogical content knowledge self-efficacy towards technology integration in colleges of education in south-west Nigeria. *Journal of Science, Technology, Mathematics and Education (JOSMED), 15*(3), 131-141. Retrieved from https://www.academia.edu/40632193/ASSESSING_PRE-SERVICE_TEACHERS_TECHNOLOGICAL_PEDAGOGICAL_CONTENT_KNOWLEDGE_SELF-EFFICACY_TOWARDS_TECHNOLOGY_INTEGRATION_IN_COLLEGES_OF_EDUCATION_IN_SOUTH-WEST_NIGERIA

Abstract: "This study is a comparative investigation of pre-service teachers' technological pedagogical content knowledge (TPACK) self-efficacy toward technology integration. The study employed a descriptive survey research design. A multistage sampling technique was used to obtain the sample, which comprised of 603 NCE II pre-service teachers from southwest colleges of education [in] Nigeria. TPACK self-efficacy questionnaire (TPACK-SQ) instrument was used to collect data on pre-service perceived self-efficacy. This instrument consisted of 42 items which [were] used to measure the 7 TPACK knowledge constructs (technology knowledge, content knowledge, pedagogy knowledge, pedagogical content knowledge, technological content knowledge, technological pedagogical knowledge and technological pedagogical content knowledge). The reliability of the instrument was determined using [the] Cronbach Alpha formula within the ranges of 0.71 to 0.86. Mean, Standard Deviation and independent samples t-test were used to analyze the data. The data collected revealed significant difference in technology knowledge (t = 2.431, p = .015) and technological pedagogical content knowledge (t = -2.072, p = .039) self-efficacy. Based on the findings, it was recommended that TPACK framework should be used as a tool to aid effective technology integration and assessment of teachers' knowledge so as to improve teacher education curriculums and build higher self-efficacy in pre-service teachers."

Cindric, I., & Greguric, M. (2019). The audacity to teach with technology: A case of integrating technology in pre-service language teacher education. *Croatian Journal of Education*, *21*(1), 157–188. https://doi.org/10.15516/cje.v21i1.3339

Abstract: "Integrating technology in ELT as a means to enhance language teaching presupposes that teachers have acquired necessary technology skills. In pre-service teacher education often the acquisition of technology skills takes place independent of other content making it rather difficult for students to perceive how technology can be applied in other areas, or how they can experience the benefits of its integration. Consequently, for in-service teachers, the integration of technology in their work depends on their knowledge of technology, knowledge of how to integrate it in language teaching, their confidence, motivation, enthusiasm, and opportunity to do so given the pressure of reaching learning outcomes within a limited time. The paper presents an action research focusing on the integration of technology in pre-service language teacher education. The driving force of action research is the need to improve teaching in three areas: (1) enrichment of course syllabus with technology; (2) student acquisition of technology skills; (3) the possibility of collaborative interdisciplinary team teaching at university level. In addition to reaching the intended aims in each segment of the intervention, the outcome of

this action research is the widening of the project to include others affected by the practice, i.e. students themselves, their peers, and consequently their future students and their colleagues."

Crâciun, D. (2019). Training future language teachers to educate the digital generation. *Journal of Educational Sciences*, *39*(1), 90–107. https://doi.org/10.35923/jes.2019.1.08

Abstract: "For the students in today's secondary education, digital technology is part of their everyday life, which is why their generation has been named by researchers digital natives, Net-generation, Millennials, etc. These students access online information, generally based on visuals, play, communicate and collaborate in various virtual communities, they are involved in and expect immediate feedback / rewards. All these features could be valued in school as well. Thus, in the school environment, the infusion of technology should be sustained with adequate training of teachers / future teachers, especially for its effective integration into the teaching activity. In this respect, in the last years, various pedagogical models have been developed in the world, the two most well-known being the Technological Pedagogical and Content Knowledge Model (TPACK) and the Substitution-Augmentation-Modification-Redefinition Model (SAMR) to highlight and explain how technology supports and / or transforms teaching-learning-evaluation activities in the increasingly complex ecosystem of the class. In this paper, we present some of the trends in the integration of ICT in language learning, exemplifying learning activities based on ICT collaborative applications, proposed, realized and evaluated by the Faculty of Letters students, the field of Philology from UVT, within the offered teacher training program by the above-mentioned institution. Activities are analysed within TPACK and SAMR, identifying types of applications that are useful in language classes and concrete ways of integrating online and / or collaborative applications, especially using mobile technology."

Crawford, D., Foulger, T., Graziana, K., & Slykhuis, D. (2019). Promoting change with technology in teacher education: Methodological decisions for using a highly collaborative, multimethod research approach. *Contemporary Issues in Technology and Teacher Education*, *19*(2), 240–255. Retrieved from https://www.learntechlib.org/p/185187/

Abstract: "This article highlights the highly collaborative, multimethod research approach used to develop the Teacher Educator Technology Competencies (TETCs): a specific list of knowledge, skills, and attitudes, developed with input from many teacher educators in the field, to help guide the professional development of teacher educators who strive to be more competent in the integration of technology. The purpose of this article is to describe and critique the sequence of three different collaborative research approaches (crowdsourcing, Delphi, and public comment) used by the TETC research team to gather critical opinions and input from a variety of stakeholders. Researchers who desire large-scale adoption of their research outcomes may consider the multimethod approach described in this article to be useful."

Curtis, M. D. (2019). Professional technologies in schools: The role of pedagogical knowledge in teaching with geospatial technologies. *Journal of Geography*, *118*(3), 130–142. https://doi.org/10.1080/00221341.2018.1544267

Abstract: "Preparing learners for the future requires twenty-first-century teaching that integrates professional tools in the classroom. Geospatial technologies (GST), which represent geographical professional technologies, lack robust integration in high school geography. Researchers continue to ask why educators teach about rather than with GST. Understanding teacher decisions is paramount. This mixed methods study examined commonalities among teachers who use GST using Mishra and Koehler's (2006) Technological, Pedagogical, Content Knowledge (TPCK) framework as a theoretical lens. This investigation examined whether geography teachers who exhibit stronger geospatial TPCK used GST more frequently than other teachers who exhibited a less developed knowledge base."

Danday, B. A. (2019). Active vs. passive microteaching lesson study: Effects on pre-service teachers' technological pedagogical content knowledge. *International Journal of Learning, Teaching and Educational Research*, *18*(6), 181–200. https://doi.org/10.26803/ijlter.18.6.11

Abstract: "The effects of the active and passive Microteaching Lesson Study (MLS) on the technological pedagogical content knowledge (TPCK) of the 18 pre-service Physics teachers were investigated using a pre-test-post-test quasi-experimental design. Scores from the content-based TPCK test, interview responses, and journal entries were analyzed using both quantitative and qualitative techniques, specifically, the Mann-Whitney U test, the Wilcoxon Signed Ranks test, the conceptual content analysis, and the constant comparative method. Results revealed that the Active Microteaching Lesson Study (Active MLS) provided more beneficial effects on the pre-service Physics teachers' overall TPCK and certain components than the Passive MLS. The implications of the findings to research and practice were discussed. Recommendations for future research were also provided."

Dewi, F., Lengkanawati, N. S., & Purnawarman, P. (2019). Teachers' consideration in technology-integrated lesson design -- A case of Indonesian teachers. *International Journal of Emerging Technologies in Learning (iJET), 14*(18), 92-107. https://doi.org/10.3991/ijet.v14i18.9806

Abstract: "The ubiquity of technology offers promising benefits of its integration in educational sector. Yet, little is known about the rationale underlying teachers' decisions concerning their educational uses within the constraints of daily classroom practice. This study aims at exploring teachers' consideration in choosing certain technology tools in the context of technology-integrated lesson design activities. Data were obtained through a focus group discussion during the lesson design which was followed by a semi structured interview. Findings for this study have enhanced the under-standing of some aspects that teachers put into consideration while designing technology-integrated lessons; identifying goals, analyzing learners, planning instructional activities, and choosing the technology tools. In addition, the findings of this study also postulate that during the lesson design activities, teachers need to be triggered by some cognitive prompts in order to sup-port them making some decision on the learning objectives, the stag-es of activities, and the technology tools they need to integrate."

Di Blas, N., Fabbri, M., & Ferrari, L. (2018). Italian teachers and technology-knowledge training. *Formare: Open Journal per la Formazione in Rete*, *18*(2), 33–47. http://dx.doi.org/10.13128/formare-23256

Abstract: "This article aims to answer the question "how are Italian teachers trained in technological skills (TK)?", in the framework of the distributed TPACK model. According to this model, different supports and sources interplay in a learning context. The discussion is based on data collected through a questionnaire delivered to more than 1,300 teachers on the job; the focus is, in particular, on lower and upper secondary school teachers. The results show how teachers benefit from a plurality of sources, preferring the "informal" ones."

De Rossi, M. (2019). Innovative teaching strategies: Enhancing the soft-skill-oriented approach through integrated onsite-online learning environments. *Formazione & Insegnamento*, *17*(1), 257–266. Retrieved from https://ojs.pensamultimedia.it/index.php/siref/article/download/3430/3274/

Abstract: ""The integration of ICT in Higher Education requires reflective design by teachers. In particular, from recent international research on the subject, it emerges that the perspective of the TPCK framework (Technological, Pedagogical, Content Knowledge) can favour an effective design reasoning of teachers. Teaching practice requires the implementation of innovative organizational models for the creation of learning environments that offer continuity between classroom and distance learning (Hybrid Instruction Solution). The empirical mix-method research involved a group of volunteer teachers of different teachings. The objective was to design and implement innovative teaching solutions using ICT in onsite/online environments to enhance specific soft skills in students. The results of a questionnaire (CAWI) given to incoming and outgoing teachers from the experience of designing and conducting the didactic action will be presented. the TPCK perspective design of integrated learning environments and the reasoned choice of coherent methodologies seem to make a soft-skill-oriented didactics feasible."

De Rossi, M., & Angeli, C. (2018). Teacher education for effective technology integration. *Italian Journal of Educational Technology*, *26*(1), 3–6. https://doi.org/10.17471/2499-4324/1055

Abstract: none (editorial)

De Rossi, M., & Restiglian, E. (2019). Hybrid solutions for didactics in higher education: An interdisciplinary workshop of 'visual storytelling' to develop documentation competences. *Tuning Journal for Higher Education*, *6*(2), 175–203. http://dx.doi.org/10.18543/tjhe-6(2)-2019pp175-203

Abstract: "The article reports on the results of a Design-Based Research path realized through a workshop about the "Visual Storytelling" (VS). The workshop aimed to develop teacher's

professional competences about digital narrative documentation to be certified through the Open Badge system. The interdisciplinary design was developed according to the ICT-TPACK framework between the two courses "Methodologies, Didactics and Technologies for Teaching" and "Educational Research" in the master's degree in primary teaching. 32 students were involved to deal with the documentation of some real educational experiences observed at school. They were asked to fill a semi-structured questionnaire at the end of the workshop. Other data came from a rubric used to evaluate VS products from three different points of views (students' self-assessment; university teachers; school teachers). The workshop stimulated the students to use technologies creatively, critically and reflectively to develop an authentic task realizing a VS product. According to the students' opinion, the workshop also facilitated collaborative processes as well as skills of self-assessment and the personalization of learning."

Dincer, S. (2019). Are data collection tools for TPACK suitable? *International Journal of Innovative Technology and Exploring Engineering* (*IJITEE*), *8*(7C2), 174–175. Retrieved from https://www.ijitee.org/wp-content/uploads/papers/v8i7c2/G10380587C219.pdf

Abstract: "Despite a lot of studies existing in the literature about TPACK, it is still not obvious how to do TPACK measurement. However, when the studies investigating measurements are reviewed, it is seen that measurements are considered in informational aspect, and applications are held in only TK aspect or limited in TPC and TCK components. In this study, it is aimed to examine the differences and relationships between measurement instruments by focusing on TPACK measurements. Another goal of the study is to give an insight on how TPACK measurements should be realized. In the research, 213 teachers from different fields working in Turkey have participated and study is designed in Descriptive Survey Model. Three different tools were used in order to collect data. The results showed a meaningful relationship between individuals' statements tools, but no meaningful relationship between individuals' statements and performance tools. As a result of the study, many measurement instruments which measure participants' TPACK measurements have been concluded that they do not actually measure TPACK. Apart from that, it has been found out that the teachers have difficulty in providing technology integration in education and the most important reason of this situation is that the teachers cannot manage to put technological knowledge content into practice."

Disney, L., Barnes, A., Ey, L., & Geng, G. (2019). Digital play in young children's numeracy learning. *Australasian Journal of Early Childhood*, *44*(2), 166–181. https://doi.org/10.1177/1836939119832084

Abstract: "Advances in technology have seen a proliferation of touch-screen interfaces available to young children. These screens have changed the way in which young children engage with digital technology; with increased exposure and use, it raises debates about the suitability of integrating digital technology within early childhood settings. There are limited empirical studies that investigate the appropriateness of emergent digital technology within the field of early childhood. Based upon the TPACK model, this timely paper thus discussed the Digital Play Model (Numeracy) and reported on a project investigating the integration of digital

technologies into childcare settings. In particular, the focus of this paper was to report on the use of games using a gestural interface device have on 3- to 4-year-old children's ability to learn numeracy concepts. This study found that young children's numeracy learning outcomes were improved. This paper also provided empirical evidence of the use of Apps via iPad technologies on young children's numeracy learning, with an implication to a need for a pedagogical model for successful integration of digital technology within early childhood settings."

Dong, Y., Xu, C., Chai, C. S., & Zhai, X. (2019). Exploring the structural relationship among teachers' technostress, technological pedagogical content knowledge (TPACK), computer self-efficacy and school support. *The Asia-Pacific Education Researcher*. Advance online publication. https://doi.org/10.1007/s40299-019-00461-5

Abstract: "With the rapid development of technologies and the gradually increasing requirements of technology integration into teaching, teachers have been facing stress to keep pace with new technologies and to design pedagogical usage of technologies. Although prior studies have examined the creators and negative impacts of technostress, insights into the effective factors relieving teachers' technostress are rather limited. To facilitate teacher improvement with technology usage and help school administrators develop preventive stress management strategies, this study constructed a structural model among teachers' technostress, TPACK, computer self-efficacy, administration support, and collegial support, which were examined through a composite instrument adapted from previous studies. Data were collected from 366K-12 in-service teachers in China. After the exploratory factor analysis and confirmatory factor analysis, the results showed that the adapted instrument had adequate validity and reliability. Further, through structural equation modeling, the results indicated that administration support predicts teachers' computer self-efficacy, and collegial support predicts both teachers' TPACK and computer self-efficacy, which in turn negatively predict their technostress. The findings imply that primary and secondary school principals need to support teachers both administratively and through the creation of collegial professional learning communities to develop TPACK and computer efficacy to reduce teachers' technostress."

Dorfman, B-S., Terrill, B., Patterson, K., Yarden, A., & Blonder, R. (2019). Teachers personalize videos and animations of biochemical processes: Results from a professional development workshop. *Chemistry Education Research and Practice*. Advance online publication. https://doi.org/10.1039/c9rp00057g

Abstract: "Despite the advancements in the production and accessibility of videos and animations, a gap exists between their potential for science teaching and their actual use in the classroom. The aim of this study was to develop and evaluate an approach to boost chemistry and biology teachers' Technological Pedagogical Content Knowledge (TPACK) and their confidence regarding the use of videos and animations in class, which are required for their effective implementation. Twelve experienced high-school chemistry and biology teachers participated in a professional development workshop including biochemistry and technological–pedagogical lectures along with video-editing instruction and practice. Teachers were provided with digital videos including high-resolution scientifically based animations and

were encouraged to edit them based on their pedagogical experience and the needs of their class. We investigated how the workshop affected teachers' TPACK-confidence and TPACK. TPACK-confidence was assessed by pre- and post-workshop questionnaires and open-ended feedback questionnaires. TPACK was assessed by analyses of the edited digital videos and pedagogical considerations submitted by the teachers. It was found that teachers' TPACK-confidence was significantly higher following the workshop. There was also a development in the teachers' TPACK. They were able to recommend to use digital videos in a variety of classroom situations based on the technological pedagogical knowledge (e.g., as an opening to a new topic) and their TPACK (e.g., to visualize complex biochemical processes). We also found a development in their video-editing skills and their knowledge of how to use this technology effectively in biochemistry lessons. Results indicate that training teachers in using technological tools while providing them with relevant Content Knowledge and TPACK, and relying on their pre-existing Pedagogical Content Knowledge may assist them develop their TPACK and TPACK-confidence. This may promote the effective use of videos and animations in biochemistry teaching."

Drennan, G., & Moll, I. (2018). A conceptual understanding of how educational technology coaches help teachers integrate iPad affordances into their teaching. *Electronic Journal of e-Learning*, *16*(2), 122–133. Retrieved from http://www.ejel.org/volume16/issue2

Abstract: "Educational technology (ed tech) coaches can help teachers and students integrate iPad affordances into their teaching and learning. A brief overview of affordance theory is provided. While investigating the under-researched practices of ed tech coaches, the authors identified iPad affordances and tabulated these, revealing links between the iPad's technological capabilities, technological affordances and pedagogical affordances. Nine iPad technological capabilities, such as the camera, were aligned with some of their technological affordances, such as taking a photo. These were matched to some pedagogical affordances, such as taking a photo for educational purposes. Finally, different categories in the table were six broad strands unveiling how ed tech coaches use them to change teacher pedagogy with benefits for teachers, students and parents. Ed tech coaches often naturally build teachers' TPACK, mostly through the SAMR model. Specifically, they change teachers' pedagogy by focusing on polysynchronous teaching and learning; digital, transformed learning; student ownership of learning with teachers as facilitators; students as teachers of content and technology; teachers' triple agendas of content elaboration, academic argument, and digital citizenship; and student creativity."

Efendioglu, A. (2018). Teachers' use of Facebook and teacher quality: Developing a Facebook Effect Scale on Teacher Quality (FESTQ) from the perspective of PCK, TPACK, and lifelong learning frameworks. *Educational Technology Research and Development*, *66*(6), 1359–1385. https://doi.org/10.1007/s11423-018-9586-x

Abstract: "The main purpose of the study is to develop a "Facebook Effect Scale on Teacher Quality" (FESTQ) based on the pedagogical content knowledge, technological pedagogical content knowledge and lifelong learning frameworks. Study participants comprised 556

teachers. Explanatory factor analysis and confirmatory factor analysis were conducted in the development and testing of the FESTQ. The results showed that the FESTQ is reliable and valid to measure Facebook effect on teacher quality. The FESTQ consists of 40 positive six-point Likert-type items along with six factors: instructional knowledge for in-class applications, general culture knowledge, individual characteristics, instructional knowledge related to student characteristics, instructional knowledge for preparing an assessment tool and special content area knowledge. The psychometric properties of the FESTQ, the study limitations and suggestions for future studies are discussed."

Eichelberger, A., & Leong, P. (2019). Using TPACK as a framework to study the influence of college faculty's beliefs on online teaching. *Educational Media International*, *56*(2), 116–133. https://doi.org/10.1080/09523987.2019.1614246

Abstract: "The purpose of this multiple case study was to understand how the beliefs of college of education faculty members about their students and teaching online influenced their online teaching. The study focused specifically on beliefs regarding student digital literacy and preparedness. The study used the Technological Pedagogical Content Knowledge (TPACK) framework as a lens for looking at online teaching. Results indicate that participants' beliefs about students did in fact influence their online teaching in a variety of ways and with differing teaching outcomes. The results of this study have implications for those who teach online as well as those who support them."

Elas, N. I. B., Majid, F. B. A., & Narasuman, S. A./I. (2019). Development of technological pedagogical content knowledge (TPACK) for English teachers: The validity and reliability. *International Journal of Emerging Technologies in Learning (iJET), 14*(20), 18-33. https://doi.org/10.3991/ijet.v14i20.11456

Abstract: "This paper discusses a study proposed to analyze technology affecting English Language Teaching (ELT). To begin with, English is an important language in a society where it acts as a bridge to connect different races in a society. However, in the circumstance of 21st-century education specifically for English Language Teaching (ELT) which has been affected by Industrial Revolution 4.0, technology plays an important part as it offers the potential to enhance teaching processes and facilitate the learning of English as Second Language (ESL). For this purpose, Technology Pedagogy Content Knowledge (TPACK) paves a way to determine the correlation between technology, pedagogy and content knowledge among the English teachers on how they incorporate these technology tools in their English teaching. Hence, because of this reason, English teachers will answer a TPACK questionnaire which was adapted from two different questionnaires to understand further how English teachers employ the technologies in ELT. Therefore, by holding on to this purpose, a questionnaire was adapted from two different major questionnaires that related to TPACK. As neighbour to the previous sentence, this research was about this adapted questionnaire that had gone through content validation by experts with more than 10 years of teaching experience in English subject. The methodology that had been used in this research was quantitative method. The data obtained was presented in the form of descriptive statistics and was analyzed by using Microsoft Excel to calculate the

Content Value Index (CVI) and Kappa Values for validity. Also, the data was presented in the form of table as it can eliminate any incomprehensibility that arises in interpreting the data. Thus, as the result, the finding of this research had supported the face and content validity and this proved that the result had high reliability and validity. Hence, this adapted questionnaire will be further research in a pilot study to test the efficiency of this instrument."

Fathi, J., & Yousefifard, S. (2019). Assessing language teachers' technological pedagogical content knowledge (TPACK): EFL students' perspectives. *Research in English Language Pedagogy*, *7*(2), 255–282. Retrieved from http://relp.khuisf.ac.ir/article_665888.html

Abstract: "Technological Pedagogical Content Knowledge (TPACK) is considered as a valuable frame for describing and understanding technology integration into different educational settings, including English as a Foreign Language (EFL) classroom. There is an accumulated body of literature on TPACK among teachers engaged in different areas of education. However, few studies have addressed the assessment of TPACK through students' perspectives in EFL settings. To address this gap, the purpose of this study was set to assess Iranian EFL students' perspectives regarding their teachers' TPACK. A total of 148 Iranian EFL students participated in this survey study. The data were collected through administering a previously validated TPACK questionnaire to the participants of the study. The findings obtained from the survey indicated that most EFL students perceived that their EFL teachers excelled in four components of TPACK such as technological knowledge (TK), pedagogical knowledge (PK), content knowledge (CK), and pedagogical content knowledge (PCK), but the teachers were perceived to be relatively less proficient in the other three components of the scale such as technological content knowledge (TCK), technological pedagogical knowledge (TPK), and TPACK. The results suggest that Iranian EFL teachers may require further training in these latter elements of the TPACK to gain the required proficiency to integrate technology more effectively into their language classrooms."

Galimullina, E., Ljubimova, E., & Ibatullin, R. (2019). SMART education technologies in mathematics teacher education – ways to integrate and progress that follows integration. *Open Learning: The Journal of Open, Distance and e-Learning*. Advance online publication. https://doi.org/10.1080/02680513.2019.1674137

Abstract: "SMART Education Technologies (SET) are already in place to provide teachers with different software packages and technologies to facilitate their teaching. However, when it comes to mathematics teaching in Russia, the situation here is different as the articulation of such SET in the Russian context is inadequate. This study redefines mathematics teacher education with smart technologies and identifies IT competencies that are needed to cope with the redefined curriculum. The designed course programme was implemented in the Elabuga Pedagogical Institute, involving 7 teachers from the Institute, 123 students (trainee teachers) and 5 schoolteachers (experts) to keep a professional eye on the learning experience. To evaluate the effectiveness of the curriculum, a survey was carried out among teachers and experts. The survey questionnaire captured the progress made in competence development alongside three modules. The progress that students were making throughout the course was

evaluated at the 'mock teaching' lesson, where students presented their individually prepared parts of a lesson on a given topic using Information and Communication Technologies (ICT). The way the learning process was organised encouraged students to use various software packages to handle maths-related problems. The research results showed that the SET learning path was flexible and allowed modification of the instructional strategy to better meet the needs of individual learners."

Goradia, T. (2018). Role of educational technologies utilizing the TPACK framework and 21st century pedagogies: Academics' perspectives. *The International Academic Forum (IAFOR) Journal of Education*, *6*(3), 43–61. https://doi.org/10.22492/ije.6.3.03

Abstract: "With the rapid development in information technology and the need to acquire 21st century skills, global trends in higher education are shifting towards using digital pedagogies. In light of this, Koehler and Mishra (2009) developed the Technological Pedagogical Content Knowledge (TPACK) framework to integrate technology with teaching. The framework has now been explored and implemented in various educational institutions. This study aims to collect academics' perspectives on various technologies and pedagogies used at the institute through the lens of the TPACK framework. A mixed-methods study, using a survey-based questionnaire, was undertaken to collect academics' perspectives. The study revealed a wide range of technologies and pedagogies being used to enhance 21st century competencies and skills. The TPACK framework provides a useful tool to gauge the learning environment and displays a complex interaction between technology, pedagogy and content knowledge specific to the learning environment. The results highlight the need to use technology for innovation and to renovate contemporary teaching practices for 21st century learning."

Guzman, D. B. (2019). Technology integration for the professional development of English teachers. *Tecné, episteme y didaxis, 46*(2), 157 - 168. Retrieved from https://revistas.pedagogica.edu.co/index.php/TED/article/view/10545

Abstract: "This paper deals with the intersection of the didactics of English as a Foreign Language (efl) and of Technological Pedagogical Content Knowledge (tpack) to guide teachers in the use of some specific tools and how to integrate them into their lessons. To meet this requirement, the researchers conducted a study to answer the question: How may the implementation of a teacher development program on tpack impact the English teaching and learning of a group of in-service teachers? The researchers collected data through observations, interviews, and before-while-after questionnaires in the implementation of two technology modules. The participants received a 48-hour course in technology during the first and second semester, as well as four follow-up sessions on the tpack these teachers use in practice, associated with the knowledge intersections, namely tpck, tck, and tpk. The professional development was organized into four stages and workshops: a) modeling a technology-enhanced activity type; b) integrating a pedagogical model in a lesson; c) developing technical skills through different virtual resources for lesson planning; d) applying tpack to design tasks for teachers' lesson plans. The results highlighted a positive impact on professional learning for teacher's development of tpack. They also revealed that teachers learned to consider the

possibility of using technology, access issues in their choices, and use of technology for lesson planning."

Han, I., Han, S., & Shin, W. S. (2019). Teachers' and students' perspectives on good teaching using technology in elementary classrooms. *International Journal of Information and Communication Technology Education*, *15*(3), 103–116. https://doi.org/10.4018/ijicte.2019070108

Abstract: "This article describes good teaching with technology from both teachers' and students' perspectives through analyzing two distinctive cases of teaching practices with technology in K-12 settings. Data was generated from teacher interviews, classroom observation, student interviews, and student reflection journals. From the analysis of these data, the authors identified four categories of behavior that were considered emblematic of good teaching with technology: deliberate instructional design, enhanced engagement, adaptive instruction, and a respectful learning environment. In addition, while teachers restructured the curriculum and integrated technologies in a way that was more meaningful for students, teachers' beliefs were embedded in their approaches towards instructional design and teaching practices, which resulted in the seamless integration of technology with sound pedagogy in a content-specific way. The results of the study provided practical guidelines for good teaching with technology and implications on what role technology should take in teaching practices."

Hardman, J. (2019). Towards a pedagogical model of teaching with ICTs for mathematics attainment in primary school: A review of studies 2008–2018. *Heliyon*, *5*(5). https://doi.org/10.1016/j.heliyon.2019.e01726

Abstract: "This article reviews literature in the field of ICTs in teaching/learning mathematics at an elementary school level. The findings to date in the field of teaching with technology in mathematics classrooms are very conflictual, with some studies indicating that ICTs impact positively on achievement through altering pedagogy, while other studies indicate that the effect on achievement and pedagogy is in fact negative. The current paper seeks to address the conflictual data by analysing a variety of meta-analyses and studies in order to answer the following questions: Does pedagogy alter with the use of ICTs in grade 6 mathematics classrooms and if so, in what ways does it vary? Secondly, does student achievement in mathematics change with the use of ICTs as teaching tools and if so, in what ways does it do so? Findings from the review indicate that student achievement in mathematics can be positively impacted using technology, *depending* on the pedagogical practices used by teachers. Technology on its own appears to have no significant impact on student's attainment. There is a dearth of findings regarding pedagogical variation with ICTs outside of a single meta-analysis that indicates that a 'constructivist' approach to teaching/learning with technology is the most effective approach to developing students' conceptually. Due to this gap in the literature, the paper outlines a theoretical framework for providing a nuanced study of pedagogical variation with ICTs drawing on Cultural Historical Activity Theory and TPACK that can track pedagogical change along various dimensions."

Hava, K. (2019). Exploring the role of digital storytelling in student motivation and satisfaction in EFL education. *Computer Assisted Language Learning*. Advance online publication. https://doi.org/10.1080/09588221.2019.1650071

Abstract: "This study aims to explore the effects of digital storytelling on student motivation and satisfaction levels in EFL education. It also investigates students' opinions on the use of digital storytelling in learning environments. In this pre-experimental study, a group of pre-service teachers (*n* = 60) created three digital stories about countries, nature, and sports within a 9-week implementation process. The motivation scale and digital storytelling satisfaction questionnaire were used as data collection tools. At the beginning and the end of the implementation process, the students were assessed on their motivation level of self-confidence, personal use, and attitude domains. The results showed that there were significant improvements in students' self-confidence and personal use after digital storytelling activity. For self-confidence and personal use, paired-samples *t*-test pointed out small effect sizes while for attitude, the changes were not significant. It is also found that digital storytelling could be beneficial for facilitating vocabulary learning, writing and speaking skills in EFL education. Overall, results show that digital storytelling might be an important and effective tool that can be utilized in learning environments to support the development of students' both language and digital skills."

Hossain, S. F. A., Shan, X., & Nurunnabi, M. (2019). Is M-learning a challenge? Students' attitudes toward the sustainable learning and performance. *International Journal of e-Collaboration*, *15*(1), 21–37. https://doi.org/10.4018/ijec.2019010102

Abstract: "Over the last few years, students' learning methods have changed considerably from traditional techniques to e-learning and m-learning. Indeed, mobile learning (m-learning) is a technology that has advanced quickly without creating any limitations on time and place, to deliver electronic learning (e-learning) with the use of personal electronics. Studies that emphasize the use of m-learning in educational institutions are surfacing. This study looks at the advanced techniques of m-learning and examines students' attitudes toward the use and implementation of m-learning techniques for the sustainability of learning. The results are based on a survey conducted with 253 students at various universities in terms of their attitudes toward and perceptions of m-learning techniques as a supplement to traditional learning methods. This study followed and checked the academic details of each student to ascertain the impact of m-learning techniques. The findings suggest that it is essential to design m-learning so that the material to be taught inside and outside the classroom is known."

Huang, X. (2018). Theoretical analysis of TPACK knowledge structure of mathematics teachers based on T-TPACK mode. *Educational Sciences: Theory & Practice*, *18*(5), 2044–2053. https://doi.org/10.12738/estp.2018.5.103

Abstract: ""In this paper, we explore the T-TPACK knowledge structure of mathematics teachers and conduct [a] questionnaire test on teachers who have supportive attitudes toward using information technologies and who are not active in applying information technologies. Based on the collected data, we conducted horizontal and vertical comparison analyses of the TPACK knowledge structure of mathematics teachers in each stage to understand the relationships between each element and find the general law of the TPACK structure of mathematics teachers, thereby distinguishing the teachers' enthusiasm for the use of information technology and comparing the TPACK structure between teachers who consider information technology as a necessary literacy and [those] who don't. All [of] these provide references for the further improvement of teachers' TPACK knowledge structures, so that in the future teachers would apply their own TPACK knowledge structures and information technology environments to design their teaching and promote the development of students' mathematical thinking."

Hong, H-Y, Lin, P-Y, Chai, C. S., Hung, G-T, & Zhang, Y. (2019). Fostering design-oriented collective reflection among preservice teachers through principle-based knowledge building activities. *Computers & Education*, *130*, 105–120. https://doi.org/10.1016/j.compedu.2018.12.001

Abstract: "Teacher's reflective capacity is an important means for teachers' growth in professionalism. This design-based research investigated the effects of knowledge building (KB) principles on pre-service teachers' reflective capacity in two intervention cycles. Particularly, the two principles of "community knowledge, collective responsibility" and "symmetric knowledge advancement" were highlighted. Participants include 25 pre-service teachers who practiced their micro-teaching during two intervention cycles. Data include: (1) records of online activities; (2) content of online feedback in the form of lesson design ideas; and (3) two open-ended surveys. Findings based on the first intervention cycle revealed that guided by the first KB principle, the participants were able to progressively work more cohesively as an online collaborative community and extend their reflective concerns about teaching to learning. However, there was no significant improvement in terms of the quality of feed-backed lesson design ideas. To address this issue, the second principle was added in the second design cycle. Moreover, using survey as a reflection tool, an attempt to extend the investigation from pre-service teachers' reflection on teaching concerns to reflection on technological, pedagogical, and content knowledge (TPACK) was taken into consideration in the second intervention iteration. As a result, the quality of the feed-backed lesson design ideas was significantly improved, indicating a sign of pre-service teachers' enhanced design fluency. In addition, the participants' design knowledge was also improved as evidenced in their deepening their reflection from basic, to more integrated, TPACK knowledge. Implications regarding principle-based, design-oriented knowledge building activities to foster reflective thinking for teacher preparation are discussed."

Ifinedo, E., Saarela, M., & Hamalanen, T. (2019). Analysing the Nigerian teacher's readiness for technology integration. *International Journal of Education & Development using*

Information & Communication Technology, *15*(3), 34–52. Retrieved from
http://ijedict.dec.uwi.edu/viewarticle.php?id=2657

Abstract: "Technology integration promises better quality in education. This integration is challenging to accomplish, especially for teachers in a developing country like Nigeria where the demand for education remains a struggle in the face of dwindling resources. The technological pedagogical content knowledge (TPACK) framework promotes designing strategies suitable for the teachers' needs. Therefore, in order to determine the readiness of the Nigerian teachers for technology integration, this study examines the Nigerian teacher educators' (N=136) TPACK and the relationship among the constructs using self-completion survey and partial least square techniques. The results reveal that among the seven knowledge constructs, the teachers' technological, pedagogical, and technological pedagogical knowledge are the most significant predictors of their TPACK. The theoretical and practical implications of the result are discussed thereafter."

Janssen, N., Knoef, M., & Lazonder, A. W. (2019). Technological and pedagogical support for pre-service teachers' lesson planning. *Technology, Pedagogy & Education*, *28*(1), 115–128. https://doi.org/10.1080/1475939X.2019.1569554

Abstract: "Successful use of ICT in the classroom requires thoughtful integration of technology and pedagogical processes during lesson preparation. This study investigated whether the information format of technological and pedagogical support affects pre-service teachers' technology integration in lesson plans. One group of pre-service teachers (n = 37) received support materials that presented technological, pedagogical and content information separately; another group (n = 36) received a version of these materials in which the technological and pedagogical information was integrated. Pre-service teachers used these support materials to create a technology-infused lesson plan. As expected, the pre-service teachers who received integrated support had relatively more design justifications in which technology and pedagogy were combined than their peers from the separate support group. However, this more advanced reasoning did not materialise in higher-quality lesson plans. Future research should investigate whether pre-training in the use of ICT could improve the effects of integrated support."

Joksimovic, M., Robertson, A., Dokic, B., & Drazeta, L. (2018). Technology-based professional development: The case of elementary school teachers in Belgrade. *Management*, *24*(1), 1–11. https://doi.org/10.7595/management.fon.2018.0029

Abstract: "Research question: This paper investigated the correlation between the perceptions of strategies that affect professional development and the obstacles to successful implementation of technology-based professional development. Motivation: The research sought to determine elements that make professional development effective in the eyes of teachers, so that they may be more apt to use what they learn in classroom practice. The concept draws upon the TPACK framework while discussion and recommendations draw upon the UTAUT stages that teachers pass through when faced with new innovations. This study

looks at the variables of a) time spent teaching, b) level of education, c) knowledge/use of computers, d) class preparation, and e) technology seminars of survey participants, to determine what demographical characteristics may have an impact on certain belief patterns surrounding professional development and technology use. Idea: The idea of this study is to look at the effectiveness of professional development to integrate technology into classroom practice and to allow for recommendations for improved technology-based professional development. Data: Data collected from a paper-based survey was completed by elementary school teachers in the school district of the city."

Jung, J., & Ottenbreit-Leftwich, A. (2019). Course-level modeling of preservice teacher learning of technology integration. *British Journal of Educational Technology*. Advance online publication. https://doi-org.proxy.wm.edu/10.1111/bjet.12840

Abstract: "We introduce an analytic approach to examine preservice teachers' technology integration learning as a process mapped against their technology-related course experience ia technology integration course. The approach assumes that (1) the preservice teachers have common course learning experience; (2) their data are collected pre- and post-course and paired; (3) the sample size is large enough to generate a structural covariance model; (4) the measurement is contextualized to the course characteristics around the types of technology tasks/tools used in the course and whether or not they were explicitly taught. The approach was applied to 368 preservice teachers' paired data to illustrate how the approach addresses the methodological issue of construct validity in TPACK measures, highlights the importance of technology integration course experience, and provides useful insights into a particular technology integration learning to its stakeholders."

Jung, Y. J., Cho, K., & Shin, W. S. (2019). Revisiting critical factors on teachers' technology integration: The differences between elementary and secondary teachers. *Asia Pacific Journal of Education*. Advance online publication. https://doi.org/10.1080/02188791.2019.1620683

Abstract: "Numerous studies have focused on both intrinsic and extrinsic variables to explain teachers' technology integration into teaching. Summarizing such studies, an encompassing construct suggests that knowledge, confidence, beliefs, and culture affect teachers' technology use. However, few studies empirically verified this theoretical construct. Moreover, despite the different circumstances and responsibilities of elementary and secondary teachers, not many scholars focused on the different relationships among the teacher-related variables in terms of technology integration. To address these gaps, this study applied an empirical dataset, which was collected from in-service teachers in South Korea, to the theoretical construct. We examined whether the variables influence teachers' technology use differently depending on the school level. Using structural equation modelling (SEM) techniques, we confirmed the significant influence of supportive culture, teachers' self-efficacy, and knowledge on teachers' technology integration except for teachers' pedagogical beliefs. In addition, the results of the multi-group SEM demonstrate differences between elementary and secondary teachers; while motivational support was the most influential variable for elementary teachers' technology use,

knowledge was the most significant variable for middle school teachers. The findings contribute to the empirical understanding of what influences teachers' use of technology in practice."

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

Abstract: "This paper investigates the readiness degree among Arabic language teachers in Ma'an Directorate of Education for integrating flipped classroom in teaching according to technological, pedagogical and content knowledge TPACK framework and its domains. The study sample consisted of (118) Arabic language teachers; (82) of them responded to a questionnaire that measured their readiness. The researchers used descriptive statistics, ANOVA and T-test. The data analyses revealed significant differences among teachers' readiness in a high degree. Two sample t-tests showed female teachers' readiness higher than male teachers at the domains: CK, PK, PCK, TPK and TPCK. Results of ANOVA revealed that experiences of teachers' readiness do not differ significantly. The study recommended the focus on integrating flipped classrooms within learning environments."

Käck, A., Barbutiu, S. M., & Fors, U. (2019). Migrant teachers' self-estimated digital competence: A study within Swedish teacher education. *Contemporary Issues in Technology and Teacher Education*, *19*(2). Retrieved from https://www.citejournal.org/volume-19/issue-2-19/general/migrant-teachers-self-estimated-digital-competence-a-study-within-swedish-teacher-education

Abstract: "An increasing number of migrant teachers with a foreign teaching degree enter Swedish teacher education to complement their studies to become eligible to teach in Swedish schools. Digital competence is one of the central skills required of teachers in today's digitized information society. Within teacher education few studies examine how migrant teachers estimate their ability and skills within digital competence. Hence, in the present study, migrant teachers' digital competence is investigated applying the framework of technology, pedagogy, and content knowledge (TPACK), the European Digital Competence Framework for Citizens (DigComp 2.1), and the Digital Competence of Educators framework (DigCompEdu). A convergent mixed-methods research design was used. The combined datasets consisted of a web survey, focus groups, individual interviews, and reflective texts, which were analyzed both quantitatively and qualitatively. The respondents' initial teacher education was obtained in 57 countries/regions. The findings highlight that migrant teachers' digital competence is diverse, scoring from both very low to high in TPACK, as well as in DigComp 2.1, from a foundation proficiency level to a highly specialized one. This result implies that further development to enhance migrant teachers' digital competence must be diversified."

Kali, Y., Sagy, O., Benichou, M., Atias, O., & Levin-Peled, R. (2019). Teaching expertise reconsidered: The technology, pedagogy, content and space (TPeCS) knowledge framework. *British Journal of Educational Technology.* Advance online publication. https://doi.org/10.1111/bjet.12847

Abstract: "School practitioners are increasingly expected to lead construction projects in their schools to create future learning spaces (FLSs) that support learning in today's networked society. This study examined the process by which practitioners of one school developed their readiness to incorporate an FLS into the school via a long-lasting research–practice partnership (RPP) that focused on co-designing learning materials for contemporary teaching. To conceptualize this process, we introduce the Technology, Pedagogy, Content and Space (TPeCS) knowledge framework, which expands current conceptualizations of teaching expertise by tying them into the emerging field of FLSs. We interpret practitioners' learning within a series of action–reaction progressive developments along a two-year timeline of the partnership. Visits to an FLS, where researchers modeled, coached and then faded their guidance along this timeline played a key role in practitioners' development of readiness to incorporate an FLS into their school. The pedagogical domain was the most challenging among all the dimensions of TPeCS. We conclude that school practitioners' involvement leading FLS endeavors within their schools can serve as an unprecedented opportunity for practitioners to develop contemporary teaching skills, with FLSs serving as ideal spaces that make pedagogy visible."

Karadag, E. (2019). Turkish medical educators' TPACK components and characters: An analysis within the framework of simulation-based medical education. *BMC Medical Education*, *19*(1). https://doi.org/10.1186/s12909-019-1664-1

Abstract:
"Background: Nowadays, a comprehensive approach is needed to describe the current status of the technology integration process and the identification of the factors that affect it, because the description and frame of the existing situation will be the starting point in the organization of the roadmap to the realization of an effective integration process. The purpose of this study is to identify the differences in technology integration of the medical educators working in Turkey and analyze these according to various variables on the basis of technological pedagogical content knowledge.
Method: Data used in the study were collected from 301 medical educators using the *TPACK-Practical Scale* and Attitude towards Technology Scale. The data were analyzed using Ward's minimum variance hierarchical clustering analysis, discriminant function analysis and multinomial logistic regression analysis.
Results: According to the results of the study, medical educators' technology integration was grouped in the following clusters, according to their TPACK: (*i*) *activity-based,* (*ii*) *student- based* and (*iii*) *topic-based*. It was found that the developed model explains 79*%* of the variance of technology integration. The implementation of simulation-based medical education in medical school and the department where they work affect the clusters to which the medical educators were assigned, whereas the gender variable didn't have an effect. The findings showed that attitudes towards technology, simulation education and working in the field of basic medical sciences increased medical educators' activity-based presence.
Conclusions: The review of the clusters and their characteristics showed that there are similarities between the items used in the designing stage of the education programs and the relationships of these items among them. Learner centered approaches are based on the

assumption that students are located at the center of the program. In these designs, teaching mostly focuses on the learner, rather than program, learning or administrative body. Individuals and their identities are crucial."

Kola, A. J., Gana, N. N., Olu, A. M. (2019). The trajectories of science educators in Nigeria and its challenge to sustainable development. *Cross-Currents: An International Peer-Reviewed Journal on Humanities & Social Sciences*, *5*(3), 53–61. Retrieved from http://crosscurrentpublisher.com/ccijhss-53/

Abstract: "The paper reviewed science education in Nigeria from the pre-independent era to date and its challenge to sustainable development. The various efforts of the government and other stakeholders at developing science education were highlighted in the paper. It was argued that science education is crucial to the sustainable development of a nation. However, achieving sustainable development in Nigeria has been difficult due to the challenge of the quality teacher. Most teachers have poor knowledge of integrating technologies in teaching and also do not have an adequate understanding of authentic learning in science. The review considered the teacher as a link between science education and sustainable development. The article was of the view that the solution to the challenge is teacher possessing adequate technological pedagogical content knowledge (TPACK). Others include teacher enhancing the scientific literacy of students and critical thinking skills."

Krutka, D. G., Carano, K. T., Cassell, L., Lavoie, M., & Davidson-Taylor, K. (2019). Wise practices and intercultural understandings: A framework for educator videoconferencing. *Journal of Research on Technology in Education*, *51*(4), 356–376. https://doi.org/10.1080/15391523.2019.1652869

Abstract: "Educators utilize videoconferencing services for a variety of purposes in their classrooms, including offering a means to connect and learn with people of different cultures, geographies, and experiences. However, there has been little research into how educators use videoconferencing in their classrooms. Drawing on technological pedagogical content knowledge (TPACK) and intercultural pedagogies, we report and analyze findings from a survey of 117 videoconferencing educators. These educators reported possibilities and challenges for using videoconferencing, particularly for intercultural experiences. We offer a framework for videoconferencing in education drawn from the wisdom of videoconferencing educators and consider implications future teaching and research."

Lachner, A., Backfish, I., & Sturmer, K. (2019). A test-based approach of modeling and measuring technological pedagogical knowledge. *Computers & Education.* Advance online publication. https://doi.org/10.1016/j.compedu.2019.103645

Abstract: "Teachers' technological pedagogical knowledge (TPK) is regarded as a critical prerequisite to effectively use technology during teaching across content domains. Previous findings on the availability of TPK, and its relation to other corresponding components of teachers' professional knowledge, however, were relatively mixed, probably because previous

research most exclusively relied on indirect measures, such as self-reports of teacher knowledge. By applying a newly developed test-based instrument to assess teachers' conceptual and situational TPK, we investigated the cognitive conditions accounting for the availability of TPK. In Study 1 (N = 284), we demonstrated that the availability of TPK depended on the level of teacher expertise. In Study 2 (N = 120), we examined the connectedness of TPK to its corresponding knowledge components (i.e., technological knowledge, pedagogical knowledge). We showed that teachers' TPK was only related to their pedagogical knowledge. The findings demonstrate that pedagogical expertise is a crucial prerequisite for TPK, which enables teachers to judge the potentials of technologies for varying teaching situations."

Liu, H., Wang, L., & Koehler, M. J. (2019). Exploring the intention-behavior gap in the technology acceptance model: A mixed-methods study in the context of foreign-language teaching in China. *British Journal of Educational Technology*. Advance online publication. https://doi-org.proxy.wm.edu/10.1111/bjet.12824

Abstract: "This study explored the strength and mechanisms of the intention-use link in the Technology Acceptance Model (TAM), based on data from a sample of 198 in-service college-level foreign-language teachers in China. Its sequential explanatory research design involved, firstly, a quantitative approach to examine the structural relations among the TAM's variables, using path analysis on survey data; and secondly, qualitative interviews with a purposive sub-sample of 16 of the same teachers, aimed at identifying potential influences on the intention-behavior gap in their student-centered technology use. Analysis of the quantitative data indicated a significant relationship between the teachers' intention to use technology and their teacher-centered technology use of technology, but a non-significant relationship between intention to use technology and their student-centered technology use. The qualitative data revealed that facilitating conditions, prior experience with technology and technological pedagogical content knowledge (TPACK) were the main obstacles to the interviewees' student-centered technology use. Other factors also played a role in educators' intention-use gaps, including habit, beliefs in students, Chinese teaching culture and assessment pressure."

Long, T., Cummins, J., & Waugh, M. (2019). To flip or not in higher education: A tale of three instructors. *The Asia-Pacific Education Researcher*. Advance online publication. https://doi.org/10.1007/s40299-019-00470-4

Abstract: "A flipped classroom is an instructional model in which students learn basic subject matter knowledge prior to classroom meetings, and then come to classroom for active learning experiences. Previous research has shown that flipped classroom have a positive impact on students' learning. Most current studies focus on students' learning experiences in flipped classroom courses. However, this qualitative case study investigated three higher education instructors' adoption of flipped classroom, with special focus on the adjustments they made and the suggestions they offered to make a successful flipped classroom course. Semi-structured interviews and course artifacts were collected from the three instructors. Findings highlighted that they made a main adjustment on allocating a brief period of in-class time to address students' pre-class learning materials, and they suggested that helping students form

good learning habits and integrating resources from other courses and other program activities into flipped classroom instruction can enhance the instructional efficiency. Findings also reveal that instructors look forward to more peer assistance among instructors."

Mailizar, M. & Fan, L. (2019). Indonesian teachers' knowledge of ICT and the use of ICT in secondary mathematics teaching. *EURASIA Journal of Mathematics, Science and Technology Education, 16*(1). https://doi.org/10.29333/ejmste/110352

Abstract: "Indonesia, like many other countries, see Information and Communication Technology (ICT) as a potential tool for enhancing the quality of education. However, there is a lack of research examining Indonesian secondary mathematics teachers' knowledge in the integration of ICT. In this study, we aimed to investigate Indonesian secondary teachers' knowledge in the use of ICT in secondary mathematics classrooms. The study employed a quantitative method with a cross-sectional survey approach. It was conducted in one of Indonesia's provinces where the data were collected from 341 secondary mathematics teachers through a questionnaire survey. The findings suggest that, to a large extent, Indonesian secondary mathematics teachers have a largely inadequate knowledge of ICT and knowledge of ICT use in teaching. Based on the findings, we argue that it is crucial to improve Indonesian teachers' knowledge of both aspects, and more training courses for teachers' knowledge development are needed."

Meletiou-Mavrotheris, M., Paparistodemou, E., & Christou, C. M. (2019). Integrating mobile devices in the mathematics curriculum: A case study of a primary school in Cyprus. *International Journal of Mobile and Blended Learning*, *11*(3), 19–37. https://doi.org/10.4018/ijmbl.2019070102

Abstract: "The case study took place in a primary school in Cyprus (student ages 6-12), which implemented a two-year multifaceted professional development program aimed at the effective integration of tablet technologies within the mathematics curriculum. The program adopted a systemic, school-based and collaborative model of professional development that focused on the broad preparation and ongoing engagement of all key stakeholders. This article focuses on research conducted during the first year of the program implementation. It portrays the initial state of mobile device use in the case study school ecosystem, describes the process of tablet integration within the school setting, and interrogates the self-reported reflections of a core team of six (n=6) teachers in the school regarding their professional learning experiences as a result of participating in the program. Findings suggest that the model of professional development adopted by the program effectively contributed to the integration of mobile devices into the school setting and to teacher professional learning."

Miguel-Revilla, D., Martinez-Ferreira, J. M., & Sanchez-Agusti, M. (2020). Assessing the digital competence of educators in social studies: An analysis in initial teacher training using the TPACK-21 Model. *Australasian Journal of Educational Technology*. Advance online publication. https://doi.org/10.14742/ajet.5281

Abstract: "Fostering the digital competence of educators is a key aspect that can be addressed in initial teacher training. The TPACK model (Mishra & Koehler, 2006) can be complemented with an approach that takes the Digital Competence of Educators framework (Redecker & Punie, 2017) and 21st century competences into account. This study analysed the practical utility of this conceptual model, and the effectiveness of a teaching intervention in a university setting, during two academic years, with social studies secondary education prospective teachers. Using a quantitative approach and the TPACK-21 questionnaire (Valtonen et al., 2017), the study examined the starting point and evolution of the participants. Results indicate the adequacy of the framework and instrument used and favourable progress towards competence after the assessment of seven factors. Although pre-service teachers showed a low degree of confidence regarding their capabilities of integrating technological with pedagogical and content knowledge, especially in three of the components, this obstacle was overcome after the intervention. It is possible to conclude that the pedagogical and conceptual orientation of the teaching proposal has shown a positive effect, evidencing the effectiveness of a comprehensive approach capable of adapting to the specificity and challenges of social studies education."

Mishra, P. (2019): Considering contextual knowledge: The TPACK diagram gets an upgrade. *Journal of Digital Learning in Teacher Education*. Advance online publication. https://doi.org/10.1080/21532974.2019.1588611

Abstract: none (editorial)

Misieng, J., Ramanair, J., & Rethinasamy, S. (2018). Measuring teachers' readiness to use technology: Technological, pedagogical and content knowledge (TPACK) pilot study. *Journal of IT in Asia*, *8*, 7–13. https://doi.org/10.33736/jita.852.2018

Abstract: "Accepted as an integral part of education, technology in teaching and learning can enhance practice not only in the traditional class but also beyond it. Schooling can now be extended to learning beyond the four enclosed walls of the classroom into the almost limitless possibility of education across time and space accessible via the domain of cyber technology. The significant contribution of technology to education has prompted educational bodies like the Malaysian Ministry of Education to prominently point out that online learning becomes the main pedagogical approach in higher learning institutions in the nation's educational blueprint. The powerful potential of technology however, can only be realised through informed and purposeful use of it by teachers. Integrating technology in the language classroom requires that teachers not only have knowledge about the Technology but interplay between three components of knowledge – Technology, Pedagogy, and Content Knowledge (TPACK) which determines the essential qualities of teacher knowledge that are required when teachers employ technology in their teaching. The main study is therefore designed to measure teachers' readiness to use technology in teaching English language in tertiary level classrooms to enhance student learning. To serve this purpose, a pilot study was carried out on 20 English language instructors to evaluate the reliability and the validity of a questionnaire that was adapted to gauge instructors' readiness in carrying out technology-mediated classrooms at a public

university in Malaysia. Correlations among items in the current study reveals lower coefficients compared to a previous study on the same instrument probably due to the smaller sample size in the current study but the correlationships are mostly positive which still suggests convergence validity. The internal consistency of the items was mostly better than two previous similar studies. Five items that seemed to be misbehaving in their respective measures were chosen based on their inter-item correlation and the item-total statistics and scrutinized via cognitive interviews with selected respondents to gain insights into the items but the results of the interviews revealed that the items are functioning as intended."

Moore, C. (2019). Heroin zombies and haunting statistics: Helping students reimagine the research product. *English Journal*, *108*(5), 31–38. Retrieved from http://www.ncte.org/journals/ej/issues/v108-5

Abstract: "The article offers information on the redesignining of [an] eleventh grade research unit by a high school teacher in Virginia after being introduced to a framework for integrating technology. Topics include the technological pedagogical content knowledge framework, which caused [the] author to question whether an essay should be the singular research product; and it solidified the idea that technology affords teachers opportunities to consider strategies for conveying content knowledge."

Muianga, X. J., Barbutiu, S. M., Hansson, H., & Mutimucuio, I. V. (2019). Teachers´ perspectives on professional development in the use of SCL approaches and ICT: A quantitative case study of Eduardo Mondlane University, Mozambique. *International Journal of Education & Development using Information & Communication Technology (IJEDICT)*, *15*(2), 79–97. Retrieved from http://www.diva-portal.org/smash/record.jsf?pid=diva2%3A1297812&dswid=9077

Abstract: "Eduardo Mondlane University (UEM) has carried out a curricular reform since 2000 to introduce Student Centered Learning (SCL) as well as the use of Information and Communication Technology (ICT). To meet the demands of this reform, UEM has introduced professional development training for teachers. The Technological Pedagogical Content Knowledge (TPACK) model was used as a theoretical framework to design the training and to evaluate how, if at all, professional development training has changed the pedagogical practice. This quantitative study has its focus on teachers who in a period of 3 years followed the training. 147 teachers returned a questionnaire, from which 92 who used SCL and ICT for teaching and learning purposes - were selected for this study. Results indicate that professional development has an impact on teachers' beliefs and practices. It supports the shift from traditional teacher-centered instruction to SCL. Teachers who attended the training are more likely to use ICT and SCL. They got a different perception of the impact of professional development on their day-to-day work and the lives of students. In addition, teachers who participated and used ICT believe that ICT contributes to changes in students' learning outcomes and the quality of educational processes."

Mutanga, P., Nezandonyi, J., & Bhukuvhani, C. (2018). Enhancing engineering education through technological pedagogical and content knowledge (TPACK): A case study. *International Journal of Education & Development using Information & Communication Technology (IJEDICT)*, *14*(3), 38–49. Retrieved from https://www.learntechlib.org/p/188282/

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

Naylor, A., & Gibbs, J. (2018). Deep learning: Enriching teacher training through mobile technology and international collaboration. *International Journal of Mobile and Blended Technology*, *10*(1), 62–77. https://doi.org/10.4018/ijmbl.2018010105

Abstract: "This article presents results from an international collaboration between college students and pre-service teachers in Norway and the UK. This research is part of a large, international project exploring and developing the interrelationship between mobile technology and teachers' perceptions of teaching and learning. Data was collected for this study through an on-line survey of 37 pre-service teachers followed by six semi-structured, in-depth interviews. The data analysis revealed the themes of collaboration, authenticity and professional learning through the use of mobile technology in the data. The collaboration enabled the use of the affordances of mobile technology to enhance the pre-service teachers' professional learning and the data suggested that this enhanced their emergent conceptions of teaching and learning."

Nazari, N., Nafissi, Z., Estaji, M., & Marandi, S. S. (2019). Evaluating novice and experienced EFL teachers' perceived TPACK for their professional development. *Cogent Education*, *6*(1). https://doi.org/10.1080/2331186x.2019.1632010

Abstract: "Technological Pedagogical Content Knowledge (TPACK) is a framework which provides a number of opportunities for conducting research in teacher education, teacher professional development, and teacher's use of technology. By applying TPACK framework, this mixed methods study aimed to examine novice and experienced EFL teachers' differences in their perceived TPACK and its influences on their professional development. To this end, for the quantitative phase, a sample of 427 EFL teachers, both male and female with different teaching experiences were selected from various English language institutes in Tehran. In the qualitative phase, 16 EFL teachers were selected for a structured interview. The quantitative results indicated that experienced teachers were of significantly higher scores in terms of pedagogical knowledge and pedagogical content knowledge subscales. In contrast, novice teachers were of significantly higher scores considering their technological knowledge, technological content knowledge, technological pedagogical knowledge, and TPACK. The qualitative results demonstrated that novice and experienced EFL teachers favored different professional development programs tailored to their needs. Likewise, they claimed that they could bridge the gap in their knowledge through collaboration in professional development courses."

Naziri, F., Rasul, M. S., & Affandi, H. M. (2019). Nominal group technique application on TPACK element requirements for design and technology teachers in Malaysia. *International Journal of Academic Research Business and Social Sciences*, *9*(4), 8–15. http://dx.doi.org/10.6007/IJARBSS/v9-i4/5810

Abstract: "Today, the use of digital technology is a hot topic for debate especially in Malaysia's education system. Teachers become role models to students as catalysts in the modernization of education, which in turn makes the learning environment more attractive and innovative. TPACK is the foundation of knowledge in communications information technology to make the world of teaching and learning fun and fun. The Nominal Group Technique is applied to assess the items available and needed to build a formative instrument of RBT's teacher's clinical supervision formative. Experts are selected based on expertise of public university lecturers, private university lecturers, teacher institute lecturers, Inspectorate and Quality Assurance officers, Curriculum Development Division, Principal, Senior Assistant Administration, Senior Co-Curriculum Assistant, State Primary Trainer and Distinguished Teacher for Design and Technology subjects. All experts are given a g-member questionnaire and a group discussion is held for consensus. A total of 15 experts were selected in the Nominal Group Technique according to their expertise. Based on expert experience and research, they suggest items that need to be modified according to the requirements of each element being constructed. Next, this app has assessed and got expert deals in terms of the number of items selected within the TPACK framework. Finally, through the application of the Nominal Group Technique expert agreement in evaluating the items required in guiding the Design and Technology teachers acquired."

Ng, W., & Fergusson, J. (2019). Technology-enhanced science partnership initiative: Impact on secondary science teachers. *Research in Science Education*, *49*(1), 219–242. https://doi.org/10.1007/s11165-017-9619-1

Abstract: "The issue of student disengagement in school science continues to pose a threat to lifting the participation rates of students undertaking STEM courses and careers in Australia and other countries globally. In Australia, several science initiatives to reverse the problem have been funded over the last two decades. Many of these initiatives involve partnerships with scientists, science educators and with industries, as is the case in this paper. The research in this paper investigated a recent partnership initiative between secondary science teachers, scientists and an educational technology company to produce science e-modules on adaptive learning platforms, enabling students to engage in personalised, inquiry-based learning and the investigation of real-world problems. One of the objectives of the partnership project was to build theoretical and pedagogical skills in teachers to deliver science by exposing them to new ways of engaging students with new digital tools, for example analytics. Using a mixed methods approach, the research investigated science teachers' pedagogical involvement in the partnership project and their perceptions of the project's impact on their teaching and students' learning. The findings indicate that the teachers believed that new technology could enhance their teaching and students' learning and that while their students were motivated by the online modules, there was still a need for scaffolding for many of the students. The effectiveness of this would depend on the teachers' ability to internalise the new technological and content knowledge resulting from the partnership and realign them with their existing pedagogical framework. The research is significant in identifying elements for successful partnership projects as well as challenges that need to be considered. It is significant in facilitating continuous discourse about new evidence-based pedagogical approaches to science education in engaging students to learn STEM subjects in a twenty-first century digitally connected future that is focused on learning at a personal level."

Nguyen, B. D., Lee, K. W., Tan, C. K. (2019). Understanding Vietnamese preservice TEFL teachers' TPACK development with design-based learning via reflective learning. *Journal of Education, Psychology and Counseling*, *4*(31), 154–169. Retrieved from http://www.ijepc.com/PDF/IJEPC-2019-31-06-14.pdf

Abstract: "The present study is aimed at understanding pre-service teachers' Technological Pedagogical and Content Knowledge (TPACK) development with Design-based Learning (DBL) in a blended learning course on Technology enhanced learning. Reflection was employed to probe the preservice teachers' TPACK development and the complex interrelationship between the seven knowledge components. Through content analysis of the participants' reflective journals and thematic analysis of their interviews, the findings revealed that there was certainly some evidence of growth in some of their TPACK components although content knowledge, technological content knowledge and pedagogical content knowledge were still limited. Both Design-based Learning environment and the reflective tool have proven to be useful platforms for the preservice teachers to enhance their learning experiences of technology use, and their willingness and confidence to apply what they learned in their future teaching practice."

Oda, K., Herman, T., & Hasan, A. (2019). Properties and impacts of TPACK-based GIS professional development for in-service teachers. *International Research in Geographical and Environmental Education.* Advance online publication. https://doi.org/10.1080/10382046.2019.1657675

Abstract: "This article reports on professional development in which twenty-four middle- or high-school teachers learned about integration of the Geographic Information System (GIS) in science or social science classes. We analyzed qualitative data obtained from the participants to examine two research questions. 1) What were the most relevant and useful skills and knowledge the teachers acquired from this professional development? And, 2) what were the approaches they intended to use in integrating GIS with instruction. We sought to understand the properties and impacts of our professional development designed through Technological Pedagogical Content Knowledge (TPACK). The article concludes with implications for further research on geospatial training in the TPACK theoretical framework."

Oliveira, H., Henriques, A., & Gutierrez-Fallas, L. F. (2018). Integration of technology in planning lessons following an exploratory approach: A study with prospective mathematics teachers. *Perspectiva*, *36*(2), 421–446. https://doi.org/10.5007/2175-795x.2018v36n2p421

Abstract: "The present study was carried out in the didactic component of the Master's degree in Mathematics Teaching for the 3rd cycle of elementary school and high school, at University of Lisbon, with the goal of understanding the professional knowledge of prospective teachers (PT) regarding the integration of digital technologies in mathematics teaching, from the perspective of exploratory teaching. Adopting the theoretical model of Technological Pedagogical Content Knowledge (TPACK) it was specifically aimed to to know the level of development of PT's TPACK in the dimensions of curriculum, learning, and teaching. The data analysis focuses on the detailed lesson plans that the PT groups have elaborated and their justifications for the options taken, in two consecutive semesters of the course. The results show a positive evolution of PT's TPACK in the different dimensions, with a higher progression in the dimension concerning learning. However, it was observed from the proposals that PTs include in their plans that activities of high-level thinking are not sufficiently targeted nor the student's autonomy is promoted in their learning about the use of technology to solve the proposed tasks. Recognizing that planning for the technology integration into mathematics teaching is a complex practice, meaningful experiences, closer to classroom reality, are required during initial training so that PTs' learners se technology in order to transform teaching and create opportunities for students' learning within the framework of the exploratory teaching."

Oner, D. (2020). A virtual internship for developing technological pedagogical content knowledge. *Australasian Journal of Educational Technology*. Advance online publication. https://doi.org/10.14742/ajet.5192

Abstract: "This study examines the use of a virtual internship (an epistemic game) for developing preservice teachers' technological pedagogical content knowledge (TPACK). TPACK aims to capture the essential qualities of teacher knowledge that are needed for integrating technology into teaching. Virtual internships are computer-based professional practicum simulation games where participants assume the role of a professional, work collaboratively on authentic tasks, and engage in complex professional thinking. The online collaborative chat records of 33 preservice teachers who played the game over the course of 8 weeks were analysed using epistemic network analysis (ENA), which made it possible to examine the dynamic connections between various TPACK domains over time. The analysis showed that participants' TPACK representations gradually became more complex in terms of the number of pedagogical considerations and the strength of connections between pedagogical considerations, technology, and content. Suggestions are made for designing learning environments that aim to develop preservice teachers' TPACK."

Ortega-Sánchez, D. & Gómez-Trigueros, I. M. (2019). Didactics of historical-cultural heritage QR codes and the TPACK model: An analytic revision of three classroom experiences in Spanish higher education contexts. *Education Sciences*, *9*(2), 117. https://doi.org/10.3390/educsci9020117

Abstract: "This study aims to establish a first reference didactic and methodological framework for the operational and effective integration of Quick Response (QR) codes in the training of Social Sciences teachers in Primary Education, paying special attention to the integrated acquisition of social, civic, and digital competences in the framework TPACK (Technological Pedagogical Content Knowledge). With this purpose, it specifies the didactic potential of these new technological resources in the teaching-learning of the Social Sciences, its eventual integration in the design and implementation of teaching innovation projects for this educational stage, and its capacity for the acquisition of competence digital teaching in Primary Education teachers in initial training. In this sense, the work explores a selection of classroom experiences and research and innovation proposals, pioneers in the field of Social Sciences Didactics in Spain, with the aim of offering an approximation and status of the didactic treatment of History and, particularly, the historical-cultural heritage in the formation of Primary Education teachers."

Ozdilek, Z., & Robeck, E. C. (2019). Enabling pre-service chemistry teachers' development of technological, pedagogical, and content knowledge (TPACK) through case-based lesson planning. *Journal of Uludag University Faculty of Education*, *32*(1), 207–225. https://doi.org/10.19171/uefad.533233

Abstract: "This study aimed to enable technological, pedagogical, and content knowledge (TPACK) development among pre-service teachers based on case-based lesson planning. A total of 21 pre-service chemistry teachers having a bachelor's degree participated in the study during their pedagogical certificate program in Turkey. Data were collected using analysis of instructional plans and open-ended questions. Results showed that case-based lesson planning provided a successful context for helping pre-service teachers to develop content knowledge

(CK), technological knowledge (TK), pedagogical knowledge (PK), and TPACK knowledge as the basis for designing effective technology-integrated chemistry lessons."

Palilonis, J., & Watt, T. (2019). Professor Garfield's 21st century digital literacy project: Supporting K-5 teachers in their digital literacy instructional efforts. *International Journal on e-Learning*. Advance online publication. Retrieved from https://www.learntechlib.org/primary/p/185269/.

Abstract: "To be digitally literate, an individual must be able to effectively make and share meaning in different modes and formats, effectively create, collaborate, and communicate in digital environments, and understand how and when technology can support these processes. However, K-5 teachers lack resources that adequately support their digital literacy instructional efforts. To overcome these challenges, we introduce novel digital literacy instructional website that leverages the popularity of one of the world's most well-known and beloved cartoon characters to deliver an age-appropriate, standards-based, cross-curricular digital literacy curriculum. A user experience and content study found that teachers offered overwhelmingly positive feedback regarding the content and pedagogical approach used to develop these novel resources."

Paneru, D. R. (2018). Information communication technologies in teaching English as a foreign language: Analysing EFL teachers' TPACK in Czech elementary schools. *Center for Educational Policy Studies Journal*, *8*(3), 141–163. https://doi.org/10.26529/cepsj.499

Abstract: "This qualitative study was carried out in five different elementary schools in the Czech Republic. It aimed to investigate how English as Foreign Language teachers developed teaching competence and practised information communication technology integration in classroom teaching. To this end, this study employed the idea of a Technology Pedagogy and Content Knowledge –TPACK -in-Action Model. It advocates a 'learning by doing' approach on (social) construction to better understand how teachers develop technological and/or computer-assisted language learning competency for teaching and practice in an English as a Foreign Language environment. Under this model, this study conducted qualitative analysis and found two different approaches in practice, which were categorised as Formal Practice and Functional Practice. The former involved a conservative mechanical practice of technology use in language teaching whereas the latter involved it in terms of (social) construction. According to analyses based on conservative practices, teachers expressed that mechanical TPACK in association with technology in classes limited the transmission of mechanical knowledge from English texts. In Functional Practice, however, teachers drawing upon alternative learning interactions expressed positive transformation results from TPACK, associated with the use of technologies integrated into class instructions as a collaborative tool for learning models. In these latter integrated practices, teachers' perceptions, practices, and reflections in combining technologies in an English as a Foreign Language environment, as new literacy skills, identified an increase in the learner's creative potential."

Parra, J., Raynor, C., Osanloo, A., & Guillaume, R. O. (2019). (Re)Imagining an undergraduate integrating technology with teaching course. *TechTrends*, *63*(1), 68–78. https://doi.org/10.1007/s11528-018-0362-x

Abstract: "The purpose of this article is to provide information from a research study that looked at the (re)imagining of a learning technologies course, *Integrating Technology with Teaching (ITT)*. The course was (re)imagined to meet the needs of students who will be preservice and future teachers. Course design for the (re)imagined course was based on 1) current literature related to TPACK, ISTE Standards and current issues in classroom technology integration and 2) a design framework including ADDIE principles and blended learning. The study was conducted during Spring 2018 in a face-to-face (F2) version of the ITT course at a Southwestern university in the US. Evaluation and feedback were collected from twenty-two students who completed the course. In addition to providing study findings, the article concludes with recommendations for the next course iteration and faculty members interested in (re)imagining learning technology courses."

Pazio, M., & Ntonia, I. (2019). Failure to engage: Exploring learning technology experiences from the vantage point of 'expert' students. *Innovations in Education and Teaching International.* Advance online publication. https://doi.org/10.1080/14703297.2019.1649173

Abstract: "This paper reports on academics' experiences of being exposed to connectivist approaches to technology integration on a PGCert course at a STEMM institution. Taking an activity theory perspective, we analyse where tensions that influenced engagement occurred. We explore reasons related to participants' understanding of what technology is, perceptions of technology and the task, attitudes to openness and sharing, and the influence of others."

Perez-Escoda, A., Garcia-Ruiz, R., & Aguaded, I. (2019). Dimensions of digital literacy based on five models of development. *Cultura y Educacion*, *31*(2), 232–266. https://doi.org/10.1080/11356405.2019.1603274

Abstract: "Digital literacy has been an emerging and increasing priority in many governments' educational and assessment policies since the first decade of the twenty-first century because it is a priority in citizenship training. The difficulty with understanding and developing it comes from its changing, transversal and flexible nature; for this reason, the fundamental objective of this research is to offer an exhaustive study of the concept by analysing the main models of digital literacy in the international context in order to offer a holistic model that incorporates the contributions from all of these initiatives. The theoretical study presented herein provides an objective, rigorous perspective on the main models of development of digital literacy: the DIGCOMP Project (European Commission), the Krumsvik model (Norway), the TPACK model (USA), the JISC model (UK), the ISTE Standards (USA) and the P21 model (USA). The conclusion offers an innovative proposal of four dimensions that should define digital literacy today, taking into account the five initiatives studied, which could be very worthwhile for researchers, educators and policymakers."

Polly, D. & Binns, I. (2018). Elementary education candidates' iIntegration of technology in science units. *Contemporary Issues in Technology and Teacher Education, 18*(4), 631-647. Retrieved from https://www.learntechlib.org/p/181127/

Abstract: "This study used the framework of technological pedagogical and content knowledge (TPACK) to examine how elementary education preservice teachers integrated technology in science units that they designed after completing courses on science education and technology integration. The findings indicate that technologies included at the end of lessons were associated with higher order thinking, while those included at the beginning or middle of lessons were focused more on lower order thinking and presenting content. Further, frequently used technology-rich activities such as viewing videos and PowerPoint presentations were associated with lower order thinking, while activities such as completing an interactive whiteboard activity or having students make presentations or videos included more opportunities to develop higher order thinking. Implications from this research suggest that science educators and teacher educators should focus more on technologies that support higher -order thinking and support course work with special attention to technology in the context of designing engaging science instruction."

Prastikawati, E. (2019). Dyned Programme as computer assisted language learning (CALL) for university students: A perception and its impact. *International Journal of Emerging Technologies in Learning (iJET)*, *14*(3), 4–20. Retrieved from https://www.learntechlib.org/p/210557/

Abstract: "This paper explores the student's perception on the application of Dyned Programme as Computer Assisted Language Learning (CALL) in English department of Universitas PGRI Semarang, Indonesia. This study is descriptive qualitative. Otherwise, it needs the statistical data in calculating the result percentage. It took 85 students of the first semester students who have already joined Integrated Course (IC) as the sample. IC is a subject which involves ICT-based learning. In this case, Dyned Programme is the ICT-based learning used as CALL. The result of this study shows that the students are satisfied with ICT facilities provided as the media in English teaching and learning. In addition, the use of Dyned Programme in English teaching and learning is well-accepted by the students. Moreover, it comes to the students' perception that shows us how important the media of ICT in English teaching learning process in order to make the students interest in learning English."

Ribeiro Rolando, L. G., Salvador, D. F., Rolando Vasconcellos, R. F. R., & da Luz, M. R. M. (2018). Evidências de validade da versão adaptada para o Português do questionário TPACK survey for meaningful learning. *Avaliação Psicológica, 17*(1), 37-47. http://dx.doi.org/10.15689/ap.2017.1701.05.13157

Abstract: "Anchored in the theoretical Technological Pedagogical Content Knowledge model, this study presents results of the transcultural adaptation process and verification of validity evidence for the TPACK Survey for Meaningful Learning. A total of 472 Biology professors from the state of Rio de Janeiro participated in the study. Results showed a good understanding and

acceptance of the adapted assertions. Statistical analyses indicate that the Brazilian version presents validity and reliability evidence, making it possible to provide an unprecedented evaluation tool in the Brazilian context, in relation to the professors' perception of their different knowledge bases."

Rochintaniawati, D., Riandi, R., Kestianty, J., Kindy, N., & Rukayadi, Y. (2019). The analysis of biology teachers' technological pedagogical content knowledge development in lesson study in West Java Indonesia. *Indonesia Journal of Science Education*, *8*(2), 201–210. https://doi.org/10.15294/jpii.v8i2.19303

Abstract: "The study aimed to analyze the development of biology teachers' Technological Pedagogical Content Knowledge (TPACK) in lesson study and to describe the role of the observer in developing teacher's TPACK during the activity. The lesson study was carried out in two from, school-based lesson study and biology teacher association based lesson study. The method used in the study was descriptive involved teachers in one school located in Bandung and member of biology teacher association in West Bandung District West Java, Indonesia. The development of TPACK was focused on five components; they are: learning objective, concept, pedagogy, evaluation, and technology. The information of teachers' TPACK was gain from CoRe + technology, and the result was categorized in pre, growing, and maturing TPACK. The study revealed that the teachers' TPACK in school-based lesson study was more in the aspect of pedagogical knowledge meanwhile teacher TPACK in biology association lesson study improved their TPACK in pedagogical knowledge, content knowledge, and technological knowledge. The development of teachers' TPACK was varied for each indicator from pra to maturing and from growing to maturing. The overall result, the development of teachers' TPACK in the two types of lesson study (school-based lesson study and Biology association lesson study) was more to the pedagogical aspect. The research suggests that teacher association based lesson study is more useful to develop teacher TPCAK than school-based lesson study, and the role of the observer is essential in developing teacher TPACK."

Rodriguez Moreno, J., Agreda Montoro, M., & Ortiz Colon, A. M. (2019). Changes in teacher training within the TPACK model framework: A systematic review. *Sustainability*, *11*(7), 1870. https://doi.org/10.3390/su11071870

Abstract: "The TPACK model represents a high-impact advance in teacher training regarding their technological, pedagogical and content knowledge. This research presents an analysis of several publications in international databases that address the matter of the TPACK model. Accordingly, a review of the scientific literature applying the documentation as a systematization method was performed. The present study analyses 37 contributions, published between 2014 and 2017, indexed in the Web of Science (WOS) and Scopus databases, with TPACK and TPCK as the applied descriptors. Thus, the documentary analysis was based on four different criteria: public, topic, main results, and methodological design. Results show that all the reviewed publications are mainly focused on studies of basic and higher education where case studies, quantitative empirical studies, and mixed studies are

predominant. Consequently, regarding the studies analyzed, there is a lack of longitudinal studies showing the teachers' actions when applying TPACK in their daily practice."

Roussinos, D., & Jimoyiannis, A. (2019). Examining primary education teachers' perceptions of TPACK and the related educational context factors. *Journal of Research on Technology in Education*, *51*(4), 377–397. https://doi.org/10.1080/15391523.2019.1666323

Abstract: "The study presented in this paper was designed to examine Greek primary education teachers' perceptions of their knowledge and skills with regards to the integration of ICT in their instructional practices. By adopting the Technological Pedagogical Content Knowledge framework, we developed an extended TPACK scale, including two sub-constructs, i.e., a) the Educational Context and b) teachers' self-assessment of TPACK abilities. The analysis of the results showed that the participants appear to believe that they have a good level of knowledge with regards to the primary TPACK domains, i.e., content, pedagogy and technology. However, most teachers perceived them separately and were not able to integrate their TPACK knowledge in order to design and implement meaningful ICT-based interventions in their classroom practice. Statistically significant differences were recorded in relation to teachers' factors, i.e., gender, teaching experience and training about ICT in education. Finally, the findings showed that teachers' efforts to implement ICT-based interventions in their classrooms could be affected by factors related to the educational context in the Greek primary schools. (Keywords: TPACK, ICT in primary education; ICT integration skills; educational context)."

Salas-Rueda, R. A. (2019). Construction and evaluation of a web application for the educational process on normal distribution considering the science of data and machine learning. *Research in Learning Technology*, *27*, 1–24. https://doi.org/10.25304/rlt.v27.2085

Abstract: "This mixed research aims at the planning, construction and implementation of a web application to facilitate the educational process on the Normal Distribution through the technological, pedagogical and content knowledge of the Technological Pedagogical Content Knowledge (TPACK) model. This study proposes the use of the PHP programming language (technological knowledge), the topics of Normal Distribution (content knowledge) and computer simulation (pedagogical knowledge) to create the Web Application on the Educational Process of Statistics (WAEPS). The sample consists of 61 students who took the subject Statistical Instrumentation for Business during the 2018 school year. The results of the linear regression (machine learning with 50% and 70% of training) indicate that the WAEPS facilitates the educational process on statistics. In fact, the WAEPS promotes the active role in the student, develops mathematical skills and facilitates the assimilation of knowledge about the calculation of upper and lower limits in the Normal Distribution by means of data simulation, interactivity and navigation. Even students consider that this web application is innovative and useful for the educational field. In addition, data science (decision tree technique) identifies various predictive models on the impact of the WAEPS in the educational process. Finally, the TPACK model is an ideal frame of reference to innovate the teaching–learning process through technological, pedagogical and content knowledge."

Samperio Pacheco, V. M. (2019). Ecuaciones estructurales en los modelos educativos: características y fases en su construcción/Structural equations in educational models: Characteristics and phases in their construction. *Apertura: Revista de Innovacion Educativa*, *11*(1), 90–103. https://doi.org/10.32870/ap.v11n1.1402

Abstract: "In this article, the characteristics and construction phases of the structural equation models are presented, a useful statistical methodology to study causal relationships through non-experimental information, specifically when the relations are of the linear type. We adopt the strategy of model development through the use of systems of structural equations, in which a model is proposed, and the purpose is to improve it through the modification of its structure or its measurements. The maximum likelihood method was used to obtain the common factors. The proposal was made based on the Technological Pedagogical Content Knowledge (TPACK) model. The results obtained from the factorial analysis where user satisfaction was analyzed when they use a Learning Management System to support their face-to-face classes at the Autonomous University of the State of Hidalgo, indicate that there is a strong correlation between the parameters of the TPACK model and the satisfaction of the students, not with the socio-cultural factors. Nor is there a correlation between sociocultural factors and student satisfaction. The importance of this research is the contribution of a model that allows us to determine the satisfaction of students through the model of structural equations with the TPACK model."

Saricoban, A., Tosuncuoglu, I., & Kirmizi, O. (2019). A technological pedagogical content knowledge assessment of pre-service EFL teachers learning to teach English as a foreign language. *Journal of Language and Linguistic Studies, 15*(3), 1122 - 1138. https://doi.org/10.17263/jlls.631552

Abstract: "The aim of the present paper is to measure the technological pedagogical content knowledge (TPACK) of pre-service EFL teachers learning to teach English as a foreign language (EFL). In order to collect data, a survey, designed and validated by Başer et al. (2016), was used. The survey consists of five sections which are technological knowledge (TK), content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK) and a fifth section that combines technological content knowledge (TCK), technological pedagogical knowledge (TPK), and TPACK items. This survey intends to assess pre-service EFL teachers' competencies in pedagogies and technologies. The present study is quantitative in nature. The participants of the study are77 pre-service EFL teachers. The results indicate that pre-service EFL teachers have a satisfactory level of competence in technological pedagogical content knowledge; yet, there are also some areas in which they need development. "

Sibananda, S., Adhikary, C., & Chattopadhyay, K. N. (2018). Exploring teacher's techno-pedagogical competency to achieve process-oriented skills of learners: A multimedia context. *Inquisitive Teacher*, *5*(2), 174–188. Retrieved from https://www.academia.edu/38304233/Exploring_Teacher_s_Techno-Pedagogical_Competency_to_Achieve_Process_Oriented_Skills_of_Learners_A_Multimedia_Context

Abstract: "In the modern progressive technological era, there is increasing interest in the incorporation and integration of technology in the classroom. To incorporate and integrate technology in the instructional strategies adequate and apposite knowledge and teacher's competency in pedagogy and technology is the prime requirement. Lack of any one will not serve the purpose of developing process-oriented skills of learners. The process-oriented skills are the lifelong experiences of our juvenile learners to cope with the hazards and threats of the constant changing environment. In this analytical article we are to explore teacher's techno-pedagogical competency, ways to enhance them and how their classroom practices help to develop process oriented skills of learners in a 'Multimedia Context.'"

Sickel, J. L. (2019). The great media debate and TPACK: A multidisciplinary examination of the role of technology in teaching and learning. *Journal of Research on Technology in Education*, *51*(2), 152–165. https://doi.org/10.1080/15391523.2018.1564895

Abstract: "This article bridges the fields of instructional design and teacher education, presenting and modernizing the media influence debate and synthesizing it with the technological pedagogical and content knowledge (TPACK) framework. Five modern technologies are presented as media comparison studies, analyzed from both the medium-as-variable and medium-and-method-as-variable perspectives, and highlighted in an example teaching and learning scenario analyzed for TPACK. The media debate is newly synthesized with TPACK, acknowledging the teacher as a critical variable in instructional success, and implications for research and teacher education and professional development are presented."

Simsek, O., & Yazar, T. (2019). Examining the self-efficacy of prospective teachers in technology integration according to their subject areas: The case of Turkey. *Contemporary Educational Technology*, *10*(3), 289–308. https://doi.org/10.30935/cet.590105

Abstract: "The purpose of this study is to examine prospective teachers' TPACK self-efficacy and variables affecting their training to integrate technology in education according to their subject areas. The survey research, a quantitative research method, was used in the study. The sample of the study is composed of senior prospective teachers (n=3553) from 19 different departments of 18 state universities in Turkey. The departments were gathered into nine subject areas by taking into consideration the criteria of prospective teachers' subject areas. Mann-Whitney U and Kruskall-Wallis H tests were used for the comparisons of the groups. The results of the study show that TPACK is perceived differently according to the subject areas. Prospective teachers think that teacher educators do not sufficiently exhibit technology integration behaviors in their lessons and participants think that they somewhat have authentic experiences in using technology in education. While both scores of TPACK self-efficacy and variables affecting prospective teachers' training to integrate technology in education are higher in favor of Foreign Languages subject area; prospective teachers in mathematics and Turkish language have lower scores than other subject areas in the study. As a result, the self-efficacy of prospective teachers' technology integration significantly differentiates."

Sointu, E. T., Valtonen, T., Hirsto, L., Kankaanpää, J., Saarelainen, M., Mäkitalo, K., Smits, A., & Manninen, J. (2019). Teachers as users of ICT from the student perspectives in higher education flipped classroom classes. *Seminar.net: International Journal of Media, Technology and Lifelong Learning*, *15*(1), 1–15.
Retrieved from https://journals.hioa.no/index.php/seminar/article/view/3402

Abstract: "The use of information and communication technology (ICT) is important in today's higher education. ICT has a central role in the skill set students are expected to master during their studies. The fast development of technology poses both possibilities and challenges for teachers. This paper is part of a larger project aimed at implementing the flipped classroom (FC) model and supporting ICT integration in higher education. In this project, teachers receive systematic support for implementing the FC model. The aim of this paper is to investigate how students assess their teachers' knowledge of pedagogy, content and technology before and after a course using the FC model. In total, 317 students responded to the pre-post-test surveys. The data were analyzed as a single group and separately for students in different year groups. Results indicate that there are statistically significant differences between the results of the pre- and post-tests. Students assess their teachers' content-specific pedagogical skills and technological pedagogical skills in teaching their subject higher after the FC courses. Students also perceived their teachers as having more positive attitudes to using technology in teaching. It was found that the difference was more apparent in second-year and higher students. Students perceived FC positively in general."

Teo, T., Sang, G., Mei, B., & Hoi, C. K. W. (2019). Investigating pre-service teachers' acceptance of Web 2.0 technologies in their future teaching: A Chinese perspective. *Interactive Learning Environments*, *27*(4), 530–546.
https://doi.org/10.1080/10494820.2018.1489290

Abstract: "In recent years, there has been an exponential growth of the explorations around the pedagogical use of Web 2.0 technologies in China. This study offers an alternate perspective by examining predictors of pre-service teachers' uptake of Web 2.0 technologies for teaching purposes. On the basis of prior related research focusing on the pedagogical use of ICT, an eight-factor research model was hypothesised. Data were collected from two universities in China through a questionnaire (N = 464). Structural equation modelling analysis results suggested that perceived usefulness, perceive enjoyment, subjective norm, technological pedagogical and content knowledge, and facilitating conditions had statistically significant direct effects on intention to use Web 2.0 technologies. The findings can help stakeholders in China (e.g. teacher educators, school leaders, and education policy makers) develop a better understanding of the realities of teachers' pedagogical use Web 2.0 technologies in China."

Thompson, M., Owho-Ovuakporie, K., Robinson, K., Kim, Y. J., Slama, R., & Reich, J. (2019). Teacher moments: A digital simulation for preservice teachers to approximate parent-teacher conversations. *Journal of Digital Learning in Teacher Education*. Advance online publication. https://doi.org/10.1080/21532974.2019.1587727

Abstract: "Interactive simulations allow preservice teachers to connect education theory and pedagogy in scaffolded environments. We created digital simulations with scenarios from in-person simulations and used them to prepare novice teachers for conversations with parents. Using a design-based approach we implemented the simulations in an education class, gathered data through surveys and observations, and incorporated feedback into subsequent designs. Novice teachers perceived the simulation as authentic and practiced maintaining composure and articulating pedagogical approaches. Recordings of novice teachers' responses produced by the simulation enabled self-reflection and peer and instructor feedback. Results suggest that these digital simulations hold promise as low-cost, flexible tools for novice teachers to engage in targeted practice in a low-stakes setting."

Trainin, G., Friedrich, L. & Deng, Q. (2018). The impact of a teacher education program re-design on technology integration in elementary preservice teachers: A five-year multi-cohort study. *Contemporary Issues in Technology and Teacher Education, 18*(4), 692-721. Retrieved from https://www.learntechlib.org/p/182424/

Abstract: "his 5-year multicohort study examined the growth of elementary preservice teachers' technology integration in the context of a teacher preparation program redesign that made integrating technologies into instruction a major focus. The authors examined how the teacher education program impacted preservice teachers' technology integration in the classroom by increasing their efficacy to integrate technology and subject areas (i.e., technology, pedagogy, and content knowledge [TPACK] efficacy) and their technology knowledge. Survey data collected from 891 participants were analyzed using thematic coding, analyses of variance, and structural equation modeling. The full program redesign showed across-cohort growth in TPACK efficacy, technology knowledge, and technology integration frequency, suggesting the possibility of increasing preservice teachers' technology integration through redesigning the teacher education program. Findings indicated that modeling by teacher educators and cooperating teachers positively impacted TPACK efficacy, technology knowledge, and technology integration frequency. Technology knowledge predicted technology integration frequency. TPACK efficacy empowered preservice teachers with confidence to integrate technology but did not predict technology integration frequency. Implications for teacher education programs are discussed."

Tusiime, W. E., Johannesen, M., & Guomundsdottir, G. B. (2019). The dilemma of teaching with digital technologies in developing countries: Experiences of art and design teacher educators in Uganda. *Nordic Journal of Comparative and International Education*, *3*(2), 55–71. https://doi.org/10.7577/njcie.3313

Abstract: "This case study explores how teacher educators use digital technologies in teaching Art and Design (A&D) in a developing country. It uses semi-structured interviews and non-participant observations to gather qualitative data from teacher educators at two teacher training institutions in central Uganda. To understand the actual use of technologies by teacher educators in the A&D classroom, analysis of the data employed concepts from van Dijk's resources and appropriation theory (RAT) and Mishra and Koehler's TPACK framework. The

findings indicate that low digital competence among teacher educators and insufficient access to appropriate hardware, software and the Internet means that A&D teacher educators in Uganda only occasionally use digital technologies in the classroom. Instead, teacher educators use non-professional software such as Microsoft Office to teach Art and Design subjects. The findings further confirm teacher educators' limited awareness of the relationship between technology, pedagogy and content knowledge in the Art and Design classroom. Insufficient access to adequate digital resources, skills and knowledge explains the low creative use of digital technologies in teaching A&D lessons."

Utama, C., Sajidan, Nurkamto, J., & Wiranto. (2019). Using TPACK as a framework to analyze TLC model. *Journal of Physics: Conference Series*, *1175*. https://doi.org/10.1088/1742-6596/1175/1/012146

Abstract: "TPACK is a conceptual framework that integrates technology, pedagogical, content, and knowledge in one unit. TPACK has been announced as a theoretical background for instructors to incorporate technology in learning effectively. The TPACK background comes from the idea that the integration of technology in learning needs to balance content, pedagogical, and technology. For educators who want to apply technology in education, they must master the three areas. This study is a systematic literature review of the TPACK background and the Technology Learning Cycle (TLC) model whose syntax begins with awareness, exploration and filtration, learning, personal and professional application, sharing and reflection. The purpose of this review is to analyze the TLC model and find out the location of each domain syntax on the TLC model that is most dominantly used by learning based on the TPACK framework. The findings show that the TLC model separates the components of technology knowledge (TK) from content pedagogical knowledge (CPK). The implications of this domain separation have an impact on the obscurity of the use of technology used in learning while using the TLC model."

Wang, C.-J. (2019). Facilitating the emotional intelligence development of students: Use of technological pedagogical content knowledge (TPACK). *Journal of Hospitality, Leisure, Sport & Tourism Education*. Advance online publication. https://doi.org/10.1016/j.jhlste.2019.100198

Abstract: "The emotional intelligence preparation of students is one of the key focuses in hospitality, tourism, and leisure education. Accordingly, this study developed an 18-h curriculum to enhance the emotional intelligence of students and investigated pre-post course differences under the framework, which integrates technological, pedagogical, and content knowledge (TPACK). Echoing the proposition by Mayer, Caruso, and Salovey's (1999) four-branch model, the current study results verified that this curriculum module effectively promoted the emotional intelligence of students in terms of self-emotion appraisal, others' emotion appraisal, use of emotion, and regulation of emotion. Furthermore, in line with Koehler and Mishra's (2009) proposition, this study provided support to the scales validity of TPACK components. Using structural equation modeling (SEM) analyses, this study also proved the positive contextual influences of components of content knowledge, pedagogical

knowledge, technology knowledge, technological content knowledge, and technological pedagogical knowledge on TPACK (Boschman, McKenney, & Voogt, 2015; Ching, Yang, Baek, & Baldwin, 2016; Koh & Chai, 2014; Koh, Chai, & Tsai, 2014). Consequently, this study verified that the implementation of TPACK framework could bridge tacit content knowledge, practice of teaching, and usage of adequate technological methods together for learning effectiveness."

Widyaningtyas, F., & Kalsum, U. (2019). Redesign of technological pedagogical science knowledge based on local culture. *Advances in Social Sciences, Education and Humanities Research*, *330*, 168–173. https://doi.org/10.2991/iceri-18.2019.34

Abstract: "This research is a literature study and the method used is Systematic Literature Review (SLR). The advancement of the educational world demands a renewal of knowledge and skills in accordance with the demands of the development of 21st century education. Teachers must be able to integrate between content, pedagogy, and technology by lifting culture local in classroom learning practices. Local culture-based learning is used by teachers who must be adapted to the subject matter presented under the curriculum. The important thing here is how students are able to understand and master the concept of science through local culture using current technology. The design of the learning model begins with a redesign of TPSK integration indicators. Redesign of Technological Pedagogical Science Knowledge (TPSK) Based on existing Local Culture can be used by teachers as a reference in developing learning model that integrates technology, pedagogy, knowledge. TPSK in science learning should be tailored to the needs and facilities available in schools."

Yang, J., Wang, Q., Wang, J., Huang, M., & Ma, Y. (2019). A study of K-12 teachers' TPACK on the technology acceptance of e-schoolbag. *Interactive Learning Environments.* Advance online publication. https://doi.org/10.1080/10494820.2019.1627560

Abstract: "E-Schoolbag is an integrated platform presented on the portable digital devices for educational purposes. Successful and sustainable integration of e-Schoolbag into the classroom often demands teachers to be equipped with essential knowledge, skills, and willingness to employ it on a voluntary basis. The purpose of this study was to examine if teacher's TPACK abilities could predict their inclination to use e-Schoolbag. A total of 1185 teachers from 45 primary and secondary schools in China participated in this study. A structural equation model was established to examine if and how the TPACK framework might affect TAM. Results showed that the teachers' TPACK level had a large impact on their acceptance of e-Schoolbag through perceived usefulness (PU) and ease of use (EOU). Specifically, the technological knowledge (TK) component was more significantly correlated with the e-Schoolbag acceptance than Pedagogical knowledge (PK) and content knowledge (CK). The path coefficient value further showed that TPACK affected the EOU more than the PU."

Yani, A., Ruhimat, M., & Mulyadi, A. (2019). SWOT analysis of technological pedagogical content knowledge (TPACK) implementation on geography learning. *IOP Conference Series: Earth and Environmental Science*, *286*, 012005. https://doi.org/10.1088/1755-1315/286/1/012005

Abstract: "Technological Pedagogical Content Knowledge (TPACK) is a learning design model that considers the relevance between material, pedagogy, and learning technology. This model is suitable to be applied to Geography subjects, but the question arises: is there enough media and learning tools available in schools to carry out TPACK-based geography learning? This study uses a survey method with a study population of all geography teachers in 3 (three) districts/ cities in West Java Province. Data was analyzed using the SWOT approach. The results showed that the main weakness of the implementation of TPACK was the limitation of learning tools/ media, and geographic subjects still grouped in the social sciences so that they received less attention from the government. In addition, the threat is a ban from the government to implement the TPACK model because it is slightly different from the applicable learning process standards. Based on the above conditions, a solution that is considered effective is conducting further research, namely identifying the tools and geography learning media needed and developing a systematic TPACK-based scientific learning model/strategy."

Young, J.R., Young, J., Hamilton, C., & Pratt, S. (2019). Evaluating the effects of professional development on urban mathematics teachers TPACK using confidence intervals. *REDIMAT – Journal of Research in Mathematics Education, 8*(3), 312-338. http://dx.doi.org/10.4471/redimat.2019.3065

Abstract: "This article presents a practical application of meta-analytic thinking to contextualize the results through direct comparisons to similar studies. The results suggest that the professional development increased mathematics teachers' perceptions of their pedagogical knowledge (PK), technological knowledge (TK), pedagogical content knowledge (PCK), and technological content knowledge (TCK). The study results also indicate that despite smaller overall effect sizes, the outcomes observed in this urban intervention were not statistically significantly different from most prior research in this area. This is important because interventions in urban schools are often characterized as less successful than other instructional environments. Because of the chosen research approach, the research results have practical as well as empirical implications for the development and delivery of mathematics professional development in urban schools."

Zambak, V. S., & Tyminski, A. M. (2019). Examining mathematical technological knowledge of pre-service middle grades teachers with *Geometer's Sketchpad* in a geometry course. *International Journal of Mathematical Education in Science and Technology*. Advance online publication. https://doi.org/10.1080/0020739X.2019.1650302

Abstract: "With the emergence of new instructional technologies, pre-service teachers are expected to develop Mathematical Technological Knowledge (MTK), which we define as teacher knowledge of technology developed as a result of exploring mathematics with technology. We examined 16 middle grades pre-service mathematics teachers' (PSMTs) MTK within a geometry course where they used the dynamic geometry software, *Geometer's Sketchpad*, as a cognitive tool. The data from this exploratory case study revealed five levels of MTK which can be used to classify the ways PSMTs understand and leverage the capabilities and limitations of this

dynamic geometry software. In our conclusion, we recommend mathematics teacher educators attend to PSMTs' different levels of utilizing dynamic geometry software in teaching and learning mathematics. These levels of MTK can also be leveraged to inform mathematics teacher educators' decisions in providing technological experiences within mathematical content and instructional technology courses."

Zini, A., Bertolini, C., Manera, L., & Contini, A. (2018). Digital storytelling in early childhood education and care: Teacher training in the STORIES project. *Italian Journal of Educational Technology*, *26*(2), 77–84. https://doi.org/10.17471/2499-4324/963

Abstract: "The key themes addressed by the Erasmus Plus STORIES project (2015-2018) are the promotion of media literacy practices in early childhood education and teachers' professional development in media education. One of the main outcomes already achieved is a training course on digital storytelling in early childhood education. Dedicated to in-service preschool teachers, the course was provided in the four countries involved in the project: Italy, Finland, Germany and Turkey. The course was designed to address all the components foreseen in the TPACK model. The paper explores the training course structure, the key contents and the activities implemented."

Chapters

Benitt, N., Schmidt, T., & Legutke, M. K. (2019). Teacher learning and technology-enhanced teacher education. In X. Gao (Ed.), *Second handbook of English language teaching*. https://doi.org/10.1007/978-3-319-58542-0_58-1

Abstract: "Technology and the advancement of digital media not only have the potential to change the way we learn languages, but also the way foreign language teachers learn to teach. Setting up and managing learning platforms, using learning software and educational apps effectively, designing complex web-based tasks, and using videoconferencing in the scope of cooperation projects are just a few examples of digital media use in the foreign language instruction of today's technology-rich schools. However, in order for teachers to become competent, critical, and reflective users of information and communication technology (ICT) in and beyond the foreign language classroom, they need to develop knowledge, a certain set of skills, and a positive attitude toward digital media use–a learning process that ideally should start early in pre-service teacher education. Moreover, teachers need to continuously challenge and rethink traditional teacher and learner roles in technology-supported teaching and learning settings. The chapter aims at answering the question of what types of knowledge and skills pre-service language teachers need to acquire in order to become digitally literate. Following an overview of current approaches in technology education, course formats and pedagogical models conducive to a meaningful integration of theory and practice in teacher education that adequately prepare pre-service teachers for competent technology use in the foreign language classroom will be discussed. After a review of current research on key concepts and approaches to the development of pre-service teachers' digital literacies, the chapter concludes with a

framework for successful technology education of language teachers comprising aspects from the models and key concepts considered here."

Eno, V. B. (2019). Improving student engagement in political science courses through application of active learning and digital learning technologies. In R. J. Blankenship & C. Baker (Eds.), *Cases on digital learning and teaching transformations in higher education* (pp. 113–134). https://doi.org/10.4018/978-1-5225-9331-7.ch007

Abstract: "This chapter explores the experiences and benefits gained from participation in Florida Agricultural and Mechanical University Provost's Digital Learning Initiative (DLI) Fellowship. Participants were equipped with relevant tools for re-designing courses for increased student engagement and attainment of student learning outcomes. The program promoted expertise in retooling courses to promote student-centered learning by exposing students to digital learning tools that reflect current and emerging technology trends in higher education as well as best practices in implementation of active learning strategies. The focus was on application of technology and implementation of active learning practices in two political science courses: a research methods and general education course. These insights have improved the author's professional development competencies; importantly, the implementation of technology-based learning has resulted in improved student achievement as evidenced by summative and formative assessment measures, and the acquisition of research and analytical skills."

Forssell, K. S., & Brazer, S. D. (2019). Principals and teachers and empowering teaching with technology. In G. Ivory, & D. Christman (Eds.), *Technologies to lead schools: Key concepts to enhance student success* (pp. 1–19). Lanham, MD: Rowman & Littlefield.

Abstract: none

Loyless, S. D. & Shaw, E. C. (2020). Beyond retreat and rebellion: Building teacher capacity for optimized student engagement and agency. In S. P. Huffman, S. Loyless & S. Albritton (Eds.), *Leveraging technology to improve school safety and student wellbeing* (pp. 227 - 243). Hershey, PA: IGI Global. https://doi.org/10.4018/978-1-7998-1766-6.ch013

Abstract: "This chapter reviews the literature to build a representation of what needs to occur for educational transformation to occur to meet the student engagement needs of 21st century learners. Effective technology integration is one of the focuses of the chapter as is a need to design professional development to provide a framework to meet technological, pedagogical, and content knowledge (TPACK) to truly affect student learning. It represents a full understanding of how to teach with technology- especially how to teach concepts in a way that enhances student learning experiences. The authors of this chapter introduce the rationale for a need to focus on instructional design of technology integration to enhance student engagement. The premise is to use technology to drive K-12 educator professional development which will build a capacity for instructional experiences to improve student dispositions."

Tan, L., & Ali, J. (2019). Investigating TPACK as professional knowledge for Australian literacy teachers. In R. Hobbs, & P. Mihailidis (Eds.), *The international encyclopedia of media literacy* (pp. 1–12). https://doi.org/10.1002/9781118978238.ieml0235

Abstract: "The evolving nature of literacy necessitates new bodies of professional knowledge that equip literacy teachers for effective teaching in the digital age. Identifying *technological pedagogical content knowledge* (TPACK) for literacy teaching is defensibly crucial to teacher education programs. While recommendations for new literacies have been put forward by literacy researchers, less is reported about the knowledge that literacy teachers need to develop students' metalanguage for responding to and composing multimedia and multimodal texts. Critical investigations of what constitutes literacy teachers' TPACK for negotiating a range of texts across modes, mediums, and contexts with their students warrant further research to inform reforms in literacy education."

3. Recent TPACK-Related Dissertations and Theses

Abuwandi, S. (2019). *Blended higher education opportunities for refugees: A comparative study* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 13879509)

Abstract: "This study aims to gain an understanding of higher education interventions taking place in refugee camps around the world that implement hybrid online and on-site models. Through an archival, database study, this uncovers the most salient characteristics of 8 international interventions (Australian Catholic University, Borderless Higher Education for Refugees, Jesuit Worldwide Learning: Higher Education at the Margins, InZone, Kepler, Mosaik, Global Border Studies, and Education for Humanity) in regard to logistics, academics, technology, and pedagogy. The study found multiple ways in which these programs seek to increase inclusion and success of refugee learners. These techniques include (1) free tuition, (2) nutrition, security, and transportation accommodations, (3) gender equity provisions, (4) course accreditation, (5) preparatory courses, (6) student support and development, (7) durable solutions related to employment, (8) tailored curricula, (9) flexibility of course structure, (10) critical thinking & reflection, (11) hybrid, adaptable, and portable course delivery, (12) on-site technology support, and (13) accommodations related to electricity and internet connectivity."

Albuloushi, A. (2019). *Investigating the relation between Saudi teachers' self-perceptions of TPACK and their practical application in lesson design* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 13904930)

Abstract: "Online education is a relatively new phenomenon in Saudi Arabian universities and best online teaching practices are still gaining ground in teacher training. At one university, which offers degrees primarily through distance education, this study sought to investigate online teachers' perceptions of their TPACK (only the TK, PK, and TPK domains) as well as analyze their practical application of TPACK knowledge in designing unit plans. The researcher

adopted a mixed methods approach to data collection by administering surveys (n = 60) and analyzing unit plans (n = 60), which were analyzed quantitatively, and conducting interviews (n = 6), which were analyzed using thematic content analysis. Survey results showed that teachers demonstrated more confidence in their technological knowledge (TK) than in their pedagogical knowledge (PK) and technological pedagogical knowledge (TPK) and these results were affirmed further by interview responses and scores on the unit plan rubrics. Unit plan analysis pointed to a significantly disproportionate usage of Knowledge Building (KB) activities in lesson design, which suggests that said participants are in dire need of stronger more comprehensive teacher training programs which focus on enhancing PK and TPK skill sets. Recommendations are given and implications of poor teacher training programs are discussed."

Atakan, I. (2019). Pre-service science teachers' TPACK efficacy levels and technology integration quality: Application of TPACK-IDDIRR model (Doctoral dissertation). Retreived from http://etd.lib.metu.edu.tr/upload/12624305/index.pdf

Abstract: "Nowadays, teachers have a great responsibility in developing and updating their technology knowledge and competences, because in an environment   where technology affects education so much, the way to achieve the desired objectives in lessons is to integrate technology into the classroom environment effectively. The purpose of the current study was to investigate the technological pedagogical content knowledge (TPACK) development in terms of TPACK efficacy levels and technology integration qualities of pre-service science teachers enrolled science methods course enhanced by the application of the TPACK-IDDIRR Model. The participants of the study were 57 undergraduate students from Elementary Science Education department. Data sources included the TPACK-Deep survey in order to evaluate the TPACK efficacy levels, lesson plans and micro-teaching observations in order to evaluate the technology integration qualities of pre-service science teachers. In the study, it was observed that the TPACK efficacy levels and technology integration of pre-service science teachers was raised considerably after the science methods course and in order to determine such increase was significant or not statistical analysis were applied. The statistical analysis revealed that the science methods course enhanced by the application of TPACK-IDDIRR model had positive effect on pre-service science teachers in terms of both TPACK efficacy levels and technology integration quality."

Bruton, C. (2018). *Impact of personalized professional learning on effective technology integration for high school teachers* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 10931927)

Abstract: "The purpose of this single-group pretest-posttest survey study was to explore the impact of personalized professional learning (PPL) on effective technology integration as perceived by core content teachers in a large urban high school. The research questions used in this study were based on the TPACK (Technology Pedagogy and Content Knowledge) survey. The survey was used to determine if there was an increase in technology knowledge, content knowledge, pedagogy knowledge, pedagogical content knowledge, technological content knowledge, technological pedagogical knowledge and/or technological pedagogical content

knowledge following the PPL self-paced experience. Three open-ended questions in the posttest provided anecdotal information regarding participant use of digital learning specialists, technical applications used, and perceptions regarding personalized professional learning.

The single-group pretest-posttest survey was given to high school teachers to allow for quantitative data to be generated. After participants engaged in the pretest survey, they spent five weeks learning different technical applications to use with their students through an online modality. Digital learning specialists provided guidance using the SAMR model so teachers had a better understanding of how to use technology at a higher level for effective technology integration with their curriculum. At the end of the five week intervention, teachers took a posttest survey to determine if the PPL impacted their ability to integrate technology effectively. Findings suggested the following: • Teachers need more training in combining their content and technology knowledge in order to choose technical applications that enhance their content and allow for effective technology integration. • The use of digital learning specialists during the intervention period proved to be a positive influence behind many of the participants' ability to access technical modules and fully integrate them into their instruction. • Regardless of gender, age, academic specialization, or level of education, teachers believe technology is essential and plays a vital role in their classrooms. • Teachers are ready to evolve from the traditional professional development style to a more progressive, personalized approach that takes into consideration their readiness, time, and interests"

Bullock, K. J. (2019). *Perception of African-American adult learners toward using technology in education* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 22592313)

Abstract: "The problem this study explored was how do African-American adult learners perceive using technology in higher education to increase their academic success. The purpose of this qualitative study was to explore how African-American adult learners perceive using technology in higher education. This study was important because it provides an understanding of how African-American adult learners use technology in higher education because perceptions plays a significant role in the learning process, as it is the process where individuals interpret things based on their experiences. to further their academic achievement. This study was also significant because it provides a means for educators to help African-American adult learners find meaningful learning experiences through utilizing educational technology to assist them with being successful in college. The framework used to guide this study was a combination of the technological pedagogical content knowledge (TPACK) and constructivism learning theories. The perceptions of using technology in this study were conclusive when technology was used in higher education. Fourteen African-American adult learners participated in this study. The data sources included individual interviews, focus groups, and the researcher's field notes. The individual and focus group interviews were coded to determine the perceptions of African-American adult learners' use of technology in education. The results indicated that African-American adult learners' perceptions of using technology based on their experiences were both positive and negative. The findings of this study indicate African-American adult learners' perceptions of technology for academic purposes had a positive impact on their learning."

Carrillo, E. (2019). *Digital game-based learning: An analysis of teacher preparation* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 13813956)

Abstract: "This study sought to explore the relationship among gender, age and prior digital game-based learning (DGBL) experience amongst high school teachers in determining the suggested content and interest of DGBL professional development. The ultimate goal of this study was to find ways to increase the preparedness of teachers to effectively implement DGBL in the classroom. This study and instrument survey questions were developed based on two theoretical frameworks. The first was the Technological Pedagogical Content Knowledge (TPACK) framework, which states that the complexity of technology integration requires an understanding of the deep connections of the three primary components (Koehler & Mishra, 2009). The second was Desimone's framework, which evaluates the effects of professional development. Desimone argues that researchers should use the common conceptual framework which includes the main features of effective professional development for studying professional development (Desimone, 2009). Fifty-seven teachers completed the 23-question online survey, which contained multiple choice, open-response and Likert-type scale questions. Teachers were asked to answer questions regarding their prior DGBL experience, suggested content and interests of DGBL professional development. A three-way ANOVA test was used to indicate if there was a relationship among gender, age and prior DGBL professional development experience."

Cleary Tennant, A. E. (2019). *Using teachers' experience with technology to understand their learning and teaching styles* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 13897669)

Abstract: "Teachers are expected to integrate technology into classrooms to prepare students to acquire 21st century skills and prepare them for future workforce. The U.S. government has spent significant resources on technology to support student learning and improve academic outcomes. Teachers will need support to be able to implement technology with fidelity in their pedagogy. The purpose of this qualitative research study was to gain an understanding of how teachers integrate technology in their pedagogy. One research question guided this research case study: How do teachers' experiences with technology provide an understanding regarding their learning and teaching styles? The participants were made up of nine teachers from a middle school in North Carolina. Participants taught mathematics, English language, science, or social studies. Data was collected via from face-to-face interviews, observations, and member checking. To analyze the data, the inductive analysis model was used. The findings indicated that experienced teachers with high technology competency embraced it because of their willingness to improve their instructional practice. Teachers with the least experience with technology did not readily embrace it and integrated it inconsistently in their instructional practice. They relied on their prior learning and teaching style for the transmission of knowledge for their instructional practice. These teachers expressed the desire for ongoing professional development in their content areas to build their confidence and experience with

technology. However, all the teachers agreed that technology is a useful resource that increased student engagement in the classroom."

Connolly, R. B (2019). *Teachers' understanding and usage of scientific data visualizations for teaching topics in earth and space science* (Doctoral dissertations). Available from ProQuest Dissertations and Theses Global database. (UMI No. 13865628)

Abstract: "Scientific data visualizations are the products, and increasingly a core practice, of modern computational science across all domains. With recent science education standards emphasizing student engagement in practices, these scientific visualizations will only increase in their availability and use for K-12 science instruction. But teacher practice is key to the successful learning outcomes for these, and any, educational technology. This study follows eleven science teachers from initial exposure in a PD program through classroom use of scientific data visualizations that address topics in Earth and Space science. The framework of technological pedagogical content knowledge (TPCK) is used to examine key dimensions of teacher knowledge that are activated as they seek to understand the data visualizations and the conceptual models that they represent, select and integrate them into their curriculum, and ultimately use them for instruction. Baseline measures of select dimensions of TPCK are measured for all teachers. Two representative case studies allow for a deep analysis of TPCK in action throughout their professional and instructional experience, and finally the impact on teachers' knowledge from the experience is examined, with implications for educative curricular material and PD program design."

Darko Agyei, E. (2019). *Tracking the development of pre-service teachers' competencies for integrating information and communication technology in the teaching of high school physics in Ghana* (Doctoral dissertation, University of the Free State, Bloemfontein, South Africa). Retrieved from http://scholar.ufs.ac.za:8080/handle/11660/9981

Abstract: "The study used a Design-Based Research approach with an explanatory case study design to track and understand the process of development of pre-service teachers' competencies for integrating information and communication technologies (ICTs) in the teaching and learning of high school physics in Ghana. To achieve this goal, Physics Education Technology (PhET) simulation was used as an interactive tool by which the study sought to: 1) produce an ICT-based intervention that fits the Ghanaian senior high school physics classroom context; 2) examine the effectiveness of the ICT intervention; and 3) provide explanations on how and why improvements in teaching using ICTs and enhanced students' learning of physics concepts through the implementation processes are possible. Seventeen pre-service physics teachers from the University of Cape Coast, Ghana participated in the study – eight of them (in their 3rd and 4th years) were the competencies understudy while the remaining nine pre-service teachers (2nd years) only served as "learners" to mimic the roles of high school students. The eight competencies understudy were enrolled in a professional development arrangement to develop their competencies in using PhET simulations to teach high school physics in an interactive and learner-centred manner. Based on the experiences gained through the professional development arrangement, this group of pre-service teachers collaborated to

design PhET simulation-supported lessons in Design Teams and afterwards, enacted the intervention in two try-outs of microteaching among themselves and their peers who only served as "learners" in the study. Questionnaires, observations, semi-structured interviews, focus group discussions, pre- and post-tests, and lesson artefacts developed by the pre-service teachers were the data sources employed in this study. The findings of the study revealed that the ICT-based intervention promoted learner-centred and interactive teaching of physics based on its inherent characteristics. The study therefore suggests that the intervention developed herein signifies the kind of ICT intervention that fits the realities in the senior high school physics classrooms in Ghana. The results also showed that the pre-service teachers improved in their teaching practices with the ICT- based intervention owing to their developed technological pedagogical and content knowledge; improved content knowledge; and developed competencies in the exploration of the PhET simulations. The PhET simulations as an interactive ICT tool was revealed to facilitate enhanced students' learning of concepts in physics, motivate students' interest in physics as a science subject as well as promote meaningful learning when used for physics instruction. Central to these findings herein is the professional development arrangement considered for the study. The specific features of the professional development arrangement that matter for the development of pre-service teachers' competencies for integrating ICT in the teaching of physics as well as the implications of the findings of this study are discussed."

DiGregorio, K. (2019). *Debunking the myths: Teachers' perceptions of the use of instructional technology in the secondary education classroom* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 13855622)

Abstract: "Instructional technology in the secondary education classroom changed the way that students learn in the classroom and how teachers deliever instruction. The phenomenological study on debunked the myths of perceived barriers by teachers in the secondary education classroom. The myths regarding instructional technology were the reluctance of change, technology as independent of pedagogy and content, technology as invasive in the classroom. The research questions that guided this study focused on the first-order barriers, capability and context beliefs of teachers as well as the how the instructional technology impacted instruction and pedagogy in the secondary classroom. A semi-structured interview protocol was developed based on research literature and secondary education teachers participated in one-to-one interviews. The emergent themes. patterns, and discrepancies from participants interview data provided insight into their lived experiences regarding the use of instructional technology in the secondary education classroom. The use of instructional technology in a secondary classroom was a result of both internal and external factors; technology was not considered invasive, teachers showed an openness to change in their instructional practices as well as shifted their pedagogical practices to meet the needs of the 21st-century student."

Drennan, G. D. (2018). *Affordances of iPads in schools: The role of the educational technology coach* (Doctoral dissertation, University of Witwatersrand, Johannesburg, South Africa). Retrieved from

Abstract: "This thesis developed a research-based model of an educational technology coach. The multi-case qualitative study, founded in grounded theory, explored how five educational technology coaches helped five teachers to integrate the affordances of iPads into their teaching, through observing one- on-one sessions and interviewing participants. A conceptual framework was developed that suggested that the iPad's technological capabilities created technological affordances that led to new pedagogical affordances, for example, the camera allowed for photos to illustrate concepts. The implications of the relationships between these three concepts were described as six ways in which teachers' pedagogy can be changed: polysynchronous teaching and learning; digitised, enhanced learning compared to digital, transformed learning; student ownership of learning with teachers as facilitators; students as teachers of content and technology; and teachers' triple agendas of content elaboration, academic argument and digital citizenship. A matrix described a dependent, influenced, serendipitous and autonomous learning model that gave insight into the relationships between direct or no direct educational technology coach instruction and built-in or purchased apps. Kolb's experiential learning theory was applied to an exemplification of the work of the educational technology coach. Examples of data instantiating elements of the TPCK and SAMR models in the work of educational technology coaches showed how teachers' TPCK benefitted. Data was categorised into a framework with eight sections: teacher-driven scheduling; educational technology coaches' relationships with teachers; teacher-driven agendas; educational technology coach-driven agendas; educational technology coaches' relationships with parents; educational technology coaches' relationships with students; empowering students; teachers' relationships with students; educational technology coaches and teachers learning from others; and personal professional development. Finally, an emerging model of an educational technology coach was proposed with the underlying principle of the educational technology coach discovering how the teacher wanted the iPad or app to better his or her pedagogy. This was followed by a consideration of the resultant concepts: meeting times; knowledge of applications; multifunctional or creative apps; trialling and testing apps; student purchases; teaching about the iPad and an app; collegiality; and modelling desired behaviour."

Everson, I. M. (2019). *Implementation of blended learning following a yearlong professional development program: A descriptive case study* (Doctoral dissertation). Retrieved from https://jscholarship.library.jhu.edu/handle/1774.2/61914

Abstract: "Research findings support the efficacy of the blended learning modality as a way to engage students and extend learning beyond the physical classroom but also note persistent barriers to teachers' technology integration efforts. The purpose of this qualitative descriptive case study was to consider the ways in which teachers implemented blended learning, specifically their decision-making processes and perceptions of changes in attitudes and beliefs about practice. The context of the study was a blended learning cohort professional development program that took place over the 2016–2017 school year across a small school division in the southeastern United States. After initial semistructured interviews with nine

blended learning cohort participants, three middle school teachers were purposively selected who showed particularly high levels of engagement in the blended learning cohort. Main case study data sources were two semistructured case study interviews and four face-to-face classroom observations. Four online classroom observations, using Google Classroom, and a researcher's journal supplemented the data. Theoretical thematic analysis was used to identify themes within and across cases. Cohort themes included: increased comfort with peer collaboration, improved student engagement, and appreciation for the asynchronous and synchronous blended format of the professional development program. Case study themes reflected that blended learning supports collaboration, differentiation of instruction, student engagement, real-world connections, and student-centered learning practices. Case study participants evinced positive attitudes and beliefs regarding the efficacy of blended learning and considered student factors when making instructional decisions. Participants' blended learning implementation varied but included opportunities for student choice and multiple paths for students to demonstrate mastery of knowledge. The researcher found that participants' classroom management hindered blended learning implementation. Participants also noted challenges related to devices and infrastructure, administrative expectations, and time. Study limitations included the sample size, and length of study. Technology professional development offerings that are embedded in the school day, offer participants opportunities to develop appropriate classroom and technology management strategies, include technology facilitation support, and encourage technology collaboration were recommended."

Golzar, J. (2019). *Educational technology use at Afghan public universities: A study of technology integration* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 13860113)

Abstract: "This study aimed to explore academic writing instructors' challenges along the process of technology integration in Afghan public universities; examine instructors' current technological, pedagogical, and content knowledge (TPACK); the relationships between TPACK and instructors' teaching experience and their educational levels. The researcher used TPACK framework proposed by Koehler & Mishra (2006) in this research. The study revealed that the instructors had pretty high level of TPACK (Mean=4.08), but average level of Technological knowledge (Mean=3.78). The study then examined two null hypotheses: a. there is no relationship between instructors' TPACK and years of teaching experience. b. there is no connection between the teachers' TPACK and their educational levels. Therefore, a t-test was run to examine the first hypothesis and it showed that there was no relationship between TPACK and years of teaching experience. Furthermore, a one-way ANOVA was operated to study the second null hypothesis, it also revealed that there was no connection between the teachers' TPACK and their educational levels. The results were not in harmony with the findings in other studies. There might be two possible reasons for such inconsistency: small size of participants in the study and large extent of contextual barriers that hindered integrating technology based on what teachers learned during their educational programs and teaching experiences. Moreover, instructors noted daunting challenges to technology integration in their classrooms. At the end, a process-model was proposed based on the findings of the study and

further discussion of the results. The study also suggested several implications and raised inquires for further research."

Greenland, A. R. (2019). *Teachers' perceptions on using information and communications technology (ICT) to improve reading comprehension: A qualitative study* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 13809776)

Abstract: "Reading comprehension skills in male adolescent students are declining across Australia, yet there is little research about teachers' perspectives about using Information and Communication Technologies as a tool to help combat this problem. The purpose of this qualitative multiple case study was to investigate teacher perceptions about whether Information and Communications Technology is working to improve reading comprehension skills among Australian male adolescent students, and if so, how. The participants of this study were five full-time teachers of male adolescent students in Sydney, Australia. Data was gathered and analyzed through thematic coding to identify common themes related to the use of Information and Communications Technology in literacy classrooms. The data analysis identified four themes, consisting of one theme for research question one, one theme for research question two, and two themes for research question three: (a) current motivation levels for male students are low, (b) inference skills for male students are poor, (c) accessibility to materials is increased through the use of Information and Communications Technology, and (d) Information and Communications Technology can be a motivational factor for male adolescent students. Four recommendations for practice included: (a) developing pedagogies that utilize the use of Information and Communications Technology in the literacy classrooms (b) increase the availability of Information and Communications Technology in the literacy classroom of schools in Sydney, Australia (c) for teachers in today's literacy classrooms in Sydney, Australia to become a more active method of change in their own classroom, and (d) for schools in Sydney, Australia to implement greater professional development for literacy teachers who are utilizing Information and Communications Technology in their classrooms. Two recommendations for future research were: (a) for a single qualitative study of theme 1 and theme 4 to be done from the perspective of male students in Sydney, Australia and (b) to conduct a quasi-experimental quantitative study at a school in the Sydney area. The outcomes of this qualitative, multiple case study may help to better understand the perspectives of teachers in Sydney, Australia on the effectiveness of Information and Communications Technology as an alternative method of literacy development."

Hall, A. B. (2019). *Personalized professional learning experiences and teacher self-efficacy for integrating technology in K-12 classrooms* (Doctoral dissertation). Retrieved from https://scholarworks.boisestate.edu/td/1525/

Abstract: "The studies in this dissertation were designed to develop an understanding of the impact of personalized professional learning experiences for K-12 teachers. These studies took place in a large, preK-12, public school district in the Southwest region of the United States. Through a combination of quantitative and qualitative methodology, these studies measured

the growth of teachers' perceptions of their ability to work with technology tool sand their self-efficacy towards integrating technology purposefully to improve the learning experiences of their students, as well as delving into the personal experiences of select teachers in the program. The Core Conceptual Framework for teacher professional development (Desimone, 2009), theories of personalized learning (Pane, Steiner, Baird, & Hamilton, 2015),and self-efficacy theory(Bandura, 1997) served as the theoretical framework for examining these experiences. The quantitative results of both studies showed a significant improvement in teachers' technology skills and self-efficacy toward integrating technology in the classroom after the personalized professional learning program. The interview findings of the second study revealed that the elements of personalization that produced the most positive learning experiences for the teachers interviewed were choice, coherence, and support. The challenges that were revealed in the interview process were an increased need for content specific courses demonstrating technology integration, a desire for increased community of practice among teachers in the program, and the overarching struggles of teaching as a practice. Based on the findings of these studies, recommendations were developed to support increased personalization and improved teacher learning experience."

Huang, W. (2019). *Integrating educational technology: A study of secondary preservice mathematics teachers* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 10843788)

Abstract: "This dissertation consists of three empirical studies investigating the ways a group of preservice teachers came to understand and implement mathematics education technologies over the course of a year-long teacher preparation program. In this small-scale explorative study, I attempted to paint a comprehensive picture of pre-service mathematics teachers' learning about technology integration. The first study adopted the theory of technological pedagogical content knowledge (TPACK) by Mishra and Koehler (2006) to analyze the preservice teachers' beliefs, knowledge, and skills in technology integration through their self-reported data. The second study employed the framework of Instrumental Orchestration from Drijvers et al. (2010) to investigate the preservice teachers' teaching practice using technology through observational data. The third paper incorporated Doerr and Zangor (2000)'s framework to explore the role technology played when the preservice teachers integrated technology into their mathematics lessons. The findings describe the complex intertwinement of teachers' knowledge and teaching practice throughout PST's learning process of integrating technology. The findings showcase pre-service teachers' capability in designing tasks that incorporate specific roles or affordances of the technology in order to support their pedagogical objective. I also explore the impact of technology in supporting mathematics discussion in the whole-class setting. The results of shared themes and individual profiles in this study provide resources for teacher educators to anticipate the common challenges faced by preservice teachers, as well as gaining a broader understanding of the potential or expectation on pre-service teachers' technology integration."

Karns, S. J. (2019). *Pairing a learning activity types short course with collaborative curriculum design: An approach to impact teachers' technological pedagogical content knowledge*

(TPACK) (Doctoral dissertation). Retrieved from http://d-scholarship.pitt.edu/36926/1/Karns%20ETD%205.3.pdf

Abstract: "In the last 20 years, spending on educational technology has increased a hundredfold worldwide (Lim, Zhao, Tondeur, Chai, & Tsai, 2013). Research suggests that the integration of that investment into classroom instruction is often inadequate to substantively impact student learning experiences (Ertmer & Otterbreit-Leftwich, 2010). The purpose of this studywas to determine the effect of a unique approach to professional development on the participant teachers' Technological Pedagogical Content Knowledge (TPACK). TPACK is defined as "...knowledge about the complex relations among technology, pedagogy, and content that enables teachers to develop appropriate and context-specific teaching strategies" (Koehler, Mishra, Kereluik, Shin, & Graham, 2014, p. 102). The seven sixth-grade teachers at North East Middle School completed an online short course on Learning Activity Types and participated in collaborative curriculum design, during which they developed an interdisciplinary thematic unit. This study also sought to determine the contextual factors that influenced the teachers as they developed the unit, as well as their beliefs about planning and technology upon conclusion. Data was gathered during the research process through individual interviews (both at the outset of the methodology and after the teachers had completed the professional development experience), observations during the planning process, and a focus group discussion. That data was coded and analyzed in order to answer the three research questions that guided the study. Having teachers complete the online short course and work together to design an interdisciplinary thematic unit resulted in a positive impact on 86 percent of the participant teachers' technological pedagogical knowledge (TPK), 71 percent of the participant teachers' technological content knowledge (TCK), and 71percentof the participant teachers' technological pedagogical content knowledge (TPACK). Contextual factors, such as access to resources and time during the day to undertake the collaborative design of instruction, were essential to this approach. The subjects shared that the collaboration with colleagues enhanced their planning and forced them reflect on how they design instruction. It also increased their awareness of technological options and improved their confidence to use technology during classroom instruction."

Maynard, J. A. (2019). *Transformational teaching & learning modeled in a flipped classroom environment* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 27525205)

Abstract: "Educational technologies have become a component of many classrooms in the 21st century, but the use of technology by beginning teachers is a concern of both educators and researchers. A gap exists between the way in which preservice teachers are taught with technology in their courses and how teachers are expected to use technology for instructional purposes. For decades research has focused on methods of instructional practices that support and improve education for student achievement. Although many studies have been conducted relating to technology, project-based learning, and 21st century learning, limited research exists in a conceptual model to prepare preservice teachers on technology integration, project-based learning, and 21st century learning in a flipped classroom environment. While preparing to

teach a course for teacher preparation, a conceptual model was designed for modeling technology integration, project-based learning, and 21st century learning in a flipped classroom environment. The resulting syllabus was constructed around a student-centered, blended learning environment while using the Universal Design of Learning and social emotional learning. The conceptual model for the research includes transformative teaching & learning and technological pedagogical content knowledge (TPACK). This mixed-methods study examined how the nature of preservice teachers' use of technology is impacted in a preparation course in which the instructor modeled technology integration, project-based learning, and 21st century learning in a flipped classroom environment. Questions addressed in the study include: (a) How do preservice teachers engage in using technology, project-based learning, and 21st century learning during the teacher preparation course?; and (b) How do preservice teachers perceive their technological, pedagogical, content, knowledge (TPACK) self-efficacy after completing the teacher preparation course? Triangulation of findings from PT-TPACK surveys, journal reflection writings, observations, student artifacts, technology presentations, and end-of-course reflections provided a comprehensive understanding of events. The study concluded that modeling technology integration, project-based learning, and 21st century learning in a flipped classroom environment during a teacher preparation course: 1) had a positive influence on improving preservice teachers' self-efficacy in technology integration, project-based learning, and 21st century learning; and 2) preservice teachers developed TPACK self-efficacy. In this mixed-methods study, implications, limitations, and recommendations for further research are discussed."

McDonald, J. (2019). *Examination of teachers' perceived technological pedagogical content knowledge and its relationship to lesson design* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 22620064)

Abstract: "School districts are increasingly adopting 1-to-1 technology initiatives to support 21st century teaching and learning; yet, there are still many challenges with the effective integration of technology into teacher instructional practices. Teacher's technological, pedagogical, content knowledge (TPACK) is an integral part in planning the instructional process for effective integration. In this quantitative study, teachers' knowledge of technology, content, and pedagogy was examined through the lens of TPACK and its relationship to their lesson design practices. Two validated TPACK instruments were used to collect data on 117 in-service teachers in a large, urban school district with a 1-to-1 technology initiative. A MANOVA and correlational analysis were performed, and results of this study indicated there were no statistically significant differences between teachers' constructs of TPACK and their years of experience in a 1-to-1 technology initiative. However, statistical significance was found between teachers' constructs of TPACK and their content area. Additionally, a correlation was found between teachers' TPACK, their lesson design practices, and design disposition. The results of this study may positively impact social change by informing school administrators and other educational change leaders in the planning of teacher instructional support to further develop teachers in the implementation of technology integration to support the 21st century learning needs of today's students."

McKee, M. (2019). *Integrating technology resources in secondary mathematics learning* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 13903641)

Abstract: "As technology becomes more prevalent and accessible, TPACK has become a valuable construct for researchers, administrators, and educators attempting to better understand how technology strategically integrated into the classroom can enhance teaching and learning. The purpose of this study was to measure the readiness of secondary mathematics teachers in the three areas of knowledge and subsequent subscales considered in the "Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge" by Punya Mishra and Matthew J. Koehler (2006). The goal behind this research was to gain insight into the variety of ways technology is being integrated into secondary mathematics learning, determine if the level of professional development provided to teachers is adequate, and establish which areas teachers feel support through increased professional development could be improved. A survey was created with quantitative Likert-scale items to assess participants' TPACK levels and qualitative questions to gauge teachers' perceptions towards professional development. The survey was distributed via email and Google Forms to secondary mathematics teachers in South Carolina. Analysis of the data was used to determine if respondents felt the professional development provided at their respective districts adequately prepares them to use emerging technologies in the classroom. Grandegenett (2008) calls for additional assistance to encourage teachers to visualize a variety of innovative strategies for integrating technology into mathematics curriculum and instruction. This study presents significant findings which advocate the necessity to revitalize professional development for secondary mathematics teachers in the interest of reinventing the position of technology in secondary mathematics learning."

Melvin, J. N. (2019). *Perspectives of adult learners and faculty on technology integration and student achievement levels* (Doctoral dissertation). Available form ProQuest Dissertations and Theses Global database. (UMI No. 13904777)

Abstract: "The purpose of the study was to develop an understanding of how adult learners and faculty perceive the integration of technology to affect the academic achievement level of the adult learner. The following two research questions guided the study: RQ1: How do adult learners and faculty, at a community college in North Carolina, perceive technology integration affecting the academic achievement of the adult learner? RQ2: How do adult learners and faculty, at a community college in North Carolina, perceive technology integration contributing to developing interactive and educational learning environments? The constructivism theory and the TPACK (Technology, Pedagogy and Content Knowledge) model were the theoretical foundations for the study. There were 14 students and six faculty participants in the study. Evidence was generated using three forms of data collection to include face-to-face student interviews, a student focus group, and a faculty focus group. The researcher analyzed and coded each data source to determine the participants' perceptions toward the research questions. The findings of the study indicated the participants perceived technology integration to have no overall effect on academic achievement. However, the participants did perceive

there to be a positive effect on student interest, engagement, and confidence when technology is effectively integrated into the academic classroom."

Mills, K. (2019). *Illuminating children's scientific funds of knowledge through social media sharing* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 13427937)

Abstract: "The ubiquitous use of social media by children offers a unique opportunity to view diverse funds of knowledge. Connecting learning to students' funds of knowledge is particularly important for non-dominant learners, who experience tensions between home, community and school science cultures. This study is embedded in a research project which iteratively designed a social media app to be integrated into a science learning program which engaged families in science in their community. I conducted an exploratory case study on children's use of a social media app for science learning and found that three focal learners (ages 9-14) often shared scientific funds of knowledge through social media in an after-school learning program and in their homes and communities. Their teachers connected some scientific funds of knowledge they shared on social media to formal science concepts. However, other scientific funds of knowledge were not obvious by observing the posts alone. Rather, these tacit funds of knowledge emerged through the triangulation of posts, interviews and observations of their learning experiences in the life-relevant science education program. The findings suggest implications for the design of technology and learning environments to facilitate the connection of children's implicit and more unconventional scientific funds of knowledge to formal science concepts. I build on these findings to explore how teachers can bridge funds of knowledge shared on social media to scientific practices in formal learning environments with a case study of three teachers from a diverse urban middle school. Using the framework for Technological Pedagogical Content Knowledge (TPACK), I seek to understand how to best support teachers to draw upon student's funds of knowledge through social media sharing and connect them to formal scientific concepts. The teachers struggled to engage in dialogue with their students about their posts, missing opportunities to gain contextual information about students' funds of knowledge, in order to facilitate connections to science concepts. These findings suggest that aspects of usability, policy and teacher beliefs are necessary to consider in order to promote the recognition of children's funds of knowledge through social media sharing in formal learning environments."

Mothobi, N. J. (2019). *A cross-country comparison of mathematics teachers' beliefs about technology pedagogical and content knowledge* (Doctoral dissertation, University of Pretoria, Pretoria, South Africa). Retrieved from https://repository.up.ac.za/handle/2263/69937

Abstract: "The purpose of this study was to determine how South African learners compare with their selected international counterparts according to their teachers_ views (Saudi Arabia, Sweden, Norway, Thailand, United Arab Emirates and Singapore). The analysis was based on the three predictor variables namely computer activities, teaching strategies as well as teaching specific mathematics content. These three predictor variables were extracted from the TIMSS

2011 teachers_ datasets and linked to the learners_ data. Furthermore, these predictor variables were analysed in a multicultural comparison. It should be taken into cognisance that the selection of the items, from the teacher questionnaire, were informed by the TPACK theoretical framework. The learners_ data was examined using factor analysis and orthogonal factor rotation. The Tucker congruent coefficient was used to determine the similarity between learners in South Africa and each of their selected international counterparts according to their teachers_ viewpoints. In this study, similarity does not imply being totally identical, but rather demonstrates which teachers' responses between South Africa and each of the countries compared with might have the same structure after the statistical analysis. The results from the analysis revealed that regardless of the socio-economic status between South Africa and each of the countries compared with, it could be claimed that some similarities can be fostered. The differences in teachers_ beliefs between South Africa and all the countries analysed provided vital information about the scope of possible classroom practice and teachers_ inclination to different teaching approaches. These results are based on the teachers_ beliefs revealed in which ways various teaching and learning strategies are conceptualised in different countries."

Mulkern, J. B. (2019). *Navigating medical education reform: Charting a course through changing landscapes of technology, pedagogy, and content* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 13881178)

Abstract: "Background: Less than two decades into the 21stcentury, U.S. medical schools are experiencing substantial curricular reform affecting multiple aspects of teaching and learning. The pace of change is rapid when compared to that of the previous century. Little changed in medical education for 100 years after Abraham Flexner's 1910 recommendations from his evaluation of North American medical schools. Using a case-study approach to examine a single medical school, this dissertation study explores pre-clerkship faculty perspectives of select curricular changes over a ten-year span at Boston University School of Medicine (BUSM). These changes include the adoption of educational technologies and student-centered pedagogical approaches, as well as curricular content integration designed for foundational science courses. Purpose: This study seeks to understand and document faculty experiences with change, factors influencing change, effective and challenging aspects of change, and recommendations for successful future changes. It also explores faculty change adoption tendencies and change leadership styles for those who led groups through a newly integrated curriculum. Methods: This is a mixed-methods study using qualitative and quantitative inquiry in three phases of data collection with two subject sets. In the first phase, qualitative data was collected from interviews with a subset of 12 subjects to inform creation of a researcher-designed survey, which was used in the second phase collecting responses from a larger pool of55subjects. The third phase collected quantitative data from an externally-validated instrument, Change Intelligence (CQ) (Trautlein, 2013), which assessed change leadership styles of the subset of 12 subjects who experienced all changes studied. Results: BUSM faculty members are motivated towards continuous improvement of the curriculum to foster students' success. Faculty are challenged by compressed time to plan and implement change and when change is mandated without opportunity for pre-decision input. BUSM faculty adopt changes at higher rates than the normal curve defined in Diffusion of Innovations (Rogers, 2003). The subset of 12 subjects

assessed for change leadership styles focus on people and process when leading change. Conclusion: Medical education change studies on the faculty perspective are limited. This study provides insight and recommendations for future study and successful change."

Odajima, R. (2019). *A case study of how and if a professional development model based on the TPACK framework builds teachers' capacity for technology integration* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 13810647)

Abstract: "Digital technologies are prevalent in society and K-12 classrooms today and the belief that educational technology can be a transformative agent of change in education is ever increasing. However, the use of technology as a transformative learning tool for all students has not yet been realized. Research in this area indicates that teachers are the leading factor impacting the utilization of technology for learning. Focused professional development along with time to develop curriculum and lessons has been identified as critical factors in changing the way teachers and students utilize technology.

The purpose of this explanatory single case study, with multiple units of analysis, was to examine the experiences and practices of nine teachers in a technology-rich high school setting to better understand the impact of a TPACK based professional development model, to understand how and why teachers make decisions regarding instructional technology integration, and to determine how their technology integration met the TPACK model of instruction.

Findings from the study revealed that the professional development model based on TPACK framework and effective professional development strategies increased teachers' use of technology, how they considered using technology and changed their instructional focus from teacher to student-centered practices. Additionally, teachers' considerations for instructional technology during planning were influenced by their teacher-centered or student-centered ideas. Finally, teachers who successfully implemented technology based on the Technology Integration Observation Instrument were those who were well versed in active learning strategies, learner-centered in their planning and implementation of instructional strategies have the greatest number of years of experience and exposure to the TPACK training model, while having varying levels of technology efficacy.

The study provided evidence to support the idea that transformational educational change through technology has little to do with the technology itself; instead, it is dependent on the pedagogical knowledge of the teacher and the context of the professional development provided to teachers. It is increasingly evident that the change sought in teaching and learning will only come about by a change in the pedagogical the practice of teachers who are appropriately prepared with student-centered learning activities and content knowledge that utilizes technology as an instructional tool to facilitate and impact learning."

Oehne, C., & Bardua, S. (2019). *University teachers' perspectives on the use of educational technology in the research supervision process: A case-study on the supervision process of students during their final thesis at the Jönköping University in Sweden* (Masters

thesis, Jonkoping University, Jonkoping, Sweden). Retrieved from https://hj.diva-portal.org/smash/get/diva2:1325845/FULLTEXT01.pdf

Abstract: "Educational technology has been proven to potentially impact higher education institutions, but the true extent of this potential often remains vague. In times when higher education and research become increasingly relevant for the economic welfare of society, research supervision itself emerges as an important field of research. This qualitative research investigates the teachers' view and approaches to the use of educational technology during the research supervision process of undergraduate and graduate students at the Jonkoping University. Through the application of the TPACK framework in higher education, we gained a better understanding of the teachers' personal values when using education technologies in their supervision process. Furthermore, we are contributing an empirical example of a TPACK application in higher education while shedding light on the decision-making of supervisors when using or not using educational technology. We conducted seven interviews with research supervisors and answered the questions of (1) how educational technology is used during research supervision and (2) why educational technology is used or not used during the supervision process. The findings showed five main cases for educational technology. We observed that supervisors mostly used educational technology when collaborating with their students whereas they preferred a more analog or hybrid approach to technology for executing individual tasks like reading and commenting. Educational technology has a supporting role for supervisors, and it is creative personal value to them through convenience, reading comfort, increased efficiency and effectiveness. For further research we suggest investigating how the personal value for teachers can be accounted for in the existing TPACK framework, and the possible benefits the application of the original or an extended version of the TPACK framework has for the field of information system research."

Pugh-Opher, F. (2019). *Mandarin teachers' experiences using technological pedagogical content knowledge in early childhood classrooms* (Doctoral dissertation). Retrieved from https://scholarworks.waldenu.edu/dissertations/7179/

Abstract: "The focus of this research study was on the experiences and perceptions of Mandarin Chinese teachers who used technologies and innovative instructional methods to teach second language skills to young learners. The conceptual framework drew on 3 theories: (a) Vygotsky's sociocultural learning theory, (b) Schön's action theory, and (c) Mishra and Koehler's technological pedagogical content knowledge (TPACK). The research questions focused on the experiences of early childhood teachers integrating TPACK to teach Mandarin Chinese and how do early childhood teachers perceive the use of instructional methods to teach Mandarin Chinese. Purposeful sampling was used to identify 8 Mandarin Chinese language teachers who taught Mandarin Chinese to students in preschool through 3rd grade. Data were collected through semistructured interviews, a questionnaire centered on TPACK, and a reflective journal entry. The data were analyzed through thematic inductive analysis using cross-case analysis to identify codes, patterns, and emerging themes that explored the teacher's experiences. The overall findings in this study indicated that teachers experienced positive outcomes integrating technology, pedagogy, and content knowledge in the early

childhood language learning classroom. The finding has the potential for social change by increasing technological and instructional resources and materials in early childhood language learning classrooms and providing on-going professional development for Mandarin Chinese language teachers in American schools."

Resendez, A. L. (2019). *Teachers' perceptions and practices on using educational technology as an instructional tool in the classroom* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 13812415)

Abstract: "Despite the rapid expansion of educational technologies in primary schools, recent research has shown that many teachers are not taking full advantage of these new tools. This study was designed to address the problem of the lack of effective technology integration in the classroom, particularly in grades third thru fifth at two school districts in the Rio Grande Valley. The purpose of this study was to examine primary teachers' perceptions of implementing technology in the classroom. Framed by Koehler and Mishra's technological pedagogical content knowledge model (TPACK), the study was guided by research questions that involved teachers' perceptions of the barriers, challenges, and successes regarding technology implementation in the primary classroom."

Scott, L. L. (2019). *Technology integration with teacher educators* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 22587787)

Abstract: "Preservice teachers are faced with many challenges as they enter their first year of teaching. This is particularly true when dealing with future-ready skills, such as technology integration in K-12 classrooms, an area where many higher education or teaching faculty may not feel comfortable or fluent enough to support preservice teachers or to model in their own instruction.

This action research study aimed to understand how faculty develop Technological Pedagogical Content Knowledge (TPACK) in ways that will help them to enhance their instruction and model technology integration for preservice teachers. An online community was created that allowed teacher educators to interact synchronously or asynchronously to collaborate, learn, and practice new technological skills. This community served as a place for teacher educators to play with new technology and to share their ideas and practices with their peers—ideally to begin the process of developing the knowledge and fluency with technology that would allow them to better support teacher education students.

Both qualitative and quantitative data were used to explore faculty's development of TPACK. A pre-survey, retrospective pre-survey, and post-survey were administered and analyzed. Also, interviews of participants and observations of the online community were used to collect qualitative data.

The results of the study showed an increase in participants' confidence for selecting technologies to enhance their instruction after they participated in the online community. Also, the participants felt more confident using strategies that combine content, technologies, and teaching approaches in their classrooms or other learning environments.

In Chapter 5, a discussion of the findings was presented, in which several main implications are shared for researchers who might be engaged in similar work. Also, the lessons learned from this action research are explained, as well as the limitations experienced in this study."

Sexton, A. (2019). *Examining the effects of modeling, practice, and reflection in technology professional development* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 22583267)

Abstract: "The purpose of this quantitative research was to assess the effects of modeling, practice, and reflection on teachers' technology self-efficacy when implemented in a structured technology professional development session. Technology is a highly researched topic in education and researchers have proven that when used effectively, technology will increase student engagement (Günüç & Kuzu, 2014). However, the lack of technology integration by educators continues to be an issue in the educational setting (Jones, 2012). The lack of technology integration relates to the professional development methods deployed to teachers (Canela, 2013). A practical suggestion for technology professional development requires strategically incorporating the Technological Pedagogical Knowledge (TPK) domains of Technological Pedagogical and Content Knowledge (TPACK) and a modified version of the Technology Learning Cycle (TLC) model to facilitate the learning process for effective technology integration. A random-assigned sample of 40 sixth to eighth-grade middle school teachers participated in the study with half participating in structured technology professional development and the other half will remain the control group. Analysis of a pretest and posttest survey provides campus and district leadership with insight on the effectiveness of a technology professional development plan. The recommendations of this study include implementation of TPK based activities within a modified TLC professional development session to address educators' technology self-efficacy."

Shellhorn, S. (2019). *Comparing administrator and teacher perceptions of technology integration using the technological pedagogical content knowledge framework and 2017 ISTE standards for educators* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 13886121)

Abstract: "The purpose of this quantitative study was to identify perceptions, determine differences in perceptions, and identify how effective the implementation of a framework such as TPACK connected to classroom technology integration of design and facilitation as defined by selected 2017 International Society for Technology in Education (ISTE) Standards for Educators. Prior research on teacher use of technology indicated teachers are not confident in incorporating technology into the classroom for student-centered learning (Sutton, 2011) and teachers and building administrators need to have a thorough understanding of the relationship of content, pedagogy, and technology. The researcher administered a survey instrument to identify content, pedagogical, and technological domains utilized by teachers and the Designer and Facilitator 2017 ISTE Standards for Educators. Descriptive and inferential statistics were used to analyze the survey items. The findings from the research revealed a gap between building administrator and teacher perceptions of technological knowledge (TK); a

statistically significant difference in building administrator and teacher perceptions of the Designer and Facilitator 2017 ISTE Standards for Educators; access and utilization of technology in Missouri public schools was prevalently available; ISTE Standards were being used for curriculum or professional development expectations; and finally the data suggested there was ample opportunity to the accessibility of technology, however, the adoption and implementation of standards, a technological framework, and aligned professional learning may be lagging behind based upon the responses of building administrators and teachers in this study."

Sreekaram, S. (2019). *Perceptions of new adjuncts on the optional professional development at University of California, Los Angeles extension* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 13865825)

Abstract: "This mixed-methods study explored perceptions of new adjuncts on various trainings with regards to satisfying their professional and aspirational needs. Three trainings were offered in fall 2018 quarter as optional professional development: workshop, and two roundtable sessions.
These trainings assisted adjuncts with their teaching skills, educational technology and pedagogy. Guidance was provided from experienced adjuncts and staff. Surveys and interviews with adjuncts, along with a focus group with staff were the sources of data for this study. A repeated measures Analysis of Covariance (ANCOVA) model was utilized. Analysis of data showed that there was a positive and statistical significance of change in perceptions of adjuncts who participated in all trainings towards fulfilling their needs, as compared to those who did not participate in any trainings. Adjuncts perceived an improvement in their professional growth based on Herzberg's motivation-hygiene theory and the trainings also fulfilled their higher-level growth needs based on Maslow's hierarchical needs theory. A large practical significance was also found which measures the practical impact of such trainings at local communities of practice."

Weerakanto, P. (2019). *Digital literacies of English language teachers and students and their perceptions of technology-enhanced language learning and teaching in Thailand* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 13813337)

Abstract: "Today, the phenomenon of emerging digital technologies has led to digital literacies that are essential in order to survive in the digital environment (Eshet-Alkalai, 2004). The role of language teachers has shifted towards developing these literacies (Leu et al., 2004) and they are expected to understand how to leverage digital technologies to assist digital natives to use them effectively (Prensky, 2001, 2010).

In response to a pressing call for teachers with advanced digital literacies and knowledge of integrating digital technologies into curricula to facilitate students' learning and improve their digital literacies (Bawden, 2008; Chun et al., 2016; Eshet-Alkalai, 2004, Kessler, 2013; Leu et al., 2004; Passey, 2011; Prensky, 2001, 2010; Reinhardt & Thorne, 2011; Stergioulas & Drenoyianni, 2011; Thorne, 2013), this descriptive study aims to assess the digital

literacies of English language in-service teachers in Thailand and explore their perceptions of technology-enhanced language teaching (TELT) in order to see whether, and the extent to which, that call has been heard.

The study employed mixed research methods to discover how teachers and students use digital technologies for academic and non-academic purposes and find out their perspectives towards technology integration into curricula, including application. Additionally, the study explored teachers' evaluation on digital web 2.0 technology-enhanced activities that were aimed to promote their digital literacy skills. For triangulation purposes, the findings were based on teacher and student surveys, classroom observations, teacher interviews, student focus groups, and artifacts. More specifically, the cases of three teachers were explored in-depth to gain insight into the general state of digital literacy skills, using TPACK-DLT frameworks to analyze their survey responses and observing their classroom practices. Technological Pedagogical Content Knowledge framework (TPACK) framework (Koehler & Mishra, 2009) is accepted as a reliable guiding principle for teachers to integrate technologies into their teaching (Koehler, Shin & Mishra, 2012; Mahdum, 2015; Pamuk, 2012). Digitally Literate Teachers (DLT) framework (White, 2015) is practical and clear to evaluate the digital literacy skills of teachers.

The overall results show that the concept of digital literacies was not clearly understood by the teachers. For that reason, they did not feel confident in integrating digital technologies into teaching although they believe the potentials of new technologies in motivating students in theory. Due to the lack of class preparation time, burdens of teaching loads, teachers' limited technology skills and students' low proficiency level, many teachers did not incorporate technology into curriculum as much as might be expected. Still, they believe it is necessary for students to have digital literacy skills. As teachers recognized their own digital competences were lower than students, they requested the university to offer technological training, faculty support, and a technology mentor.

Overall, the findings may raise awareness of practitioners, researchers, and policy makers towards their responsibility to gain a deeper understanding of digital literacies and to become digitally literate professionals in order to develop students' digital literacy skills, creativity, and critical thinking by becoming more comfortable with new learning platforms in the era of emerging digital technologies and ICTs."

Westmoreland, K. (2019). *Identifying and addressing the barriers preventing K-12 ELA teachers from integrating multimodal internet resources in curriculum design* (Doctoral dissertation). Available from ProQuest Dissertations and Theses Global database. (UMI No. 13883242)

Abstract: "Today's students spend substantial time outside of school on mobile devices every day. With that access and connectivity, communication is being delivered through multiple modalities regularly. To address this constant intentional or unintentional learning, state English language arts standards are now asking teachers to integrate diverse media and to determine meaning from sources presented through multiple modalities. The purpose of this mixed methods study is to determine the barriers that prevent K-12 ELA teachers from integrating multimodal internet resources into their pedagogical practices. A questionnaire is

used to collect quantitative data and qualitative responses. Qualitative information is used to deepen the understanding of participants' knowledge and practices of newer state standards evident through the quantitative data. In addition to finding inequities among urban, suburban, and rural school populations, the results identified two significant barriers: lack of understanding the newer state ELA and ISTE standards and lack of professional learning opportunities. These barriers could be remedied by technological pedagogical content knowledge. To help address this void, this study proposes the use of the MILA method to help teachers integrate MIR as they address learning standards."

4. Recent TPACK Presentations

Casanova Pastor, G., Maiorano Lauria, L. P., Parra Santos, M. T., & Molina Jorda, J. M. (2018, November). Chess game as pedagogical strategy for teaching: Case study in chemistry degree. In L. Gomez Chova, A. Lopez Martinez, & I. Candel Torres (Eds.), *ICERI 2018: Proceedings of 11ᵗʰ International Conference of Education, Research and Innovation* (pp. 9596–9603). https://doi.org/10.21125/iceri.2018.0775

Abstract: "Contemporary pedagogy is not only related to psychology and sociology disciplines, but also to disciplines such as neurodidactics, cronopedagogy and new technologies. Within this pedagogical environment, the professor should play an efficient and effective role providing and managing technological, didactic and psychological resources. To deal with this issue, there are several conceptual educational models which offer different multidisciplinary aspects (e.g. "Technology Pedagogy Content knowledge"-TPCK- or, in Spanish EAAP "Estilos de Aprendizaje y Actividades Polifásicas" -Learning Styles and Multi-phase Activities-). Casanova and co-authors (Casanova, Parra and Molina, 2017) have recently introduced a new conceptual model to manage efficiently throughout pedagogy based on a chess game representation of an actual educational reality according to the interpretive teaching approach. This model, that uses gamification as a tool for the professors, aims to answer the requirements of the teaching formative training strand facing side effects in a strategic way. In this contribution, the development of the model is presented for an actual and specific educative reality and the results of its application. The educative reality is referred in this work to "Inorganic Solids" subject, that is taught in the second course, second quarter from the Degree in Chemistry of Alicante University.

This subject is particularly identified after a detailed study obtained from the experiences and results of the last three courses of "Inorganic Solids" delivered by professor J.M. Molina, by two main issues: i) the early inclusion into the course (second course) because of its conceptual complexity; ii) the great demotivation that students show thought to have two origin points: demotivation itself when starting the second quarter after battling with some first year subjects, without success (something usual in a high percentage of students) and discouragement acquired during the subject pursued due to its complexity.

In this study sequential steps have been taken as it is shown next. First, educative reality of the subject has been studied, within the programme context in general for the Degree in Chemistry. In second place, that reality has been modelled throughout chess game and

interventionist strategies have been designed based on the 12 principles of neurodidactic to perform with the students. Afterwards, these strategies have been outlined into good practices and teaching methodologies with two basic characteristics: some were arranged with the students and others activities were developed holding a surprise factor. The results analyses have been done throughout evaluation of grades results in objective tests and from a student's satisfaction survey. Nowadays grades are in fact superior to those of previous years same dates, and besides, students achieve a great deal of satisfaction with methodologies applied through the developed planning. We can conclude that due to the great results encountered, chess game is endorsed as an efficient method and strategy model that enables quick and effective performance for professors which faces educational issues in a complex dynamic classroom."

Figg, C. & Khirwadkar, A. (2019, June). Preservice teachers using makerspaces to address the challenges of teaching digital learners: A self-directed creative exploration. In J. Theo Bastiaens (Ed.), *Proceedings of EdMedia + Innovate Learning* (pp. 1279-1285). Retrieved from https://www.learntechlib.org/primary/p/210268/

Abstract: "If, as current research suggests, the goal of education is to prepare K-12 students to be fluent in future ready and digital competencies, then the need for teachers to be proficient at integrating technology into the learning environments they design for students has never been greater. Preparation for teaching in digital classrooms and designing learning environments for students immersed in a digital society has become increasingly important in teacher education programs, and there is an urgent need for preservice teachers to leave teacher education programs prepared to create meaningful digital learning experiences. This paper shares the findings from an exploratory pre-pilot study that introduces makerspaces to preservice teachers, and the connections preservice teachers made between the teaching of mathematics and makerspace experiences. Preliminary findings suggest that participants did gain knowledge and skills about the use of makerspaces for teaching mathematical concepts in primary/junior learning environments, developed their Technological Pedagogical and Content Knowledge through the makerspace activities, and conducted computational thinking skills throughout the workshop. A key finding was that through participation in the in-class makerspace, participants were able to describe how makerspace activities could be used to connect multiple strands in mathematics together to enable students to learn concepts holistically."

Forkosh Baruch, A., Gadot, R., & Alon, L. (2019, March). Digital competence among ultra-orthodox and secular higher education students. In L. Gomez Chova, A. Lopez Martinez, & I. Candel Torres (Eds.), *INTED 2019: Proceedings of 13th International Technology, Education and Development Conference* (pp. 1314–1320). https://doi.org/10.21125/inted.2019.0418

Abstract: "Recent decades posed challenges for Israeli higher education institutes, due to the penetration of the Ultra-Orthodox population to the academic scene and their drive to broaden their academic capabilities [1]. Women specifically perceive themselves as gatekeepers and

agents of change and progressivism. This requires sensitivity in their coping with technology as students.

The goal of the study is to examine digital competence among Ultra-Orthodox and secular higher education students (N=161) in the first-year course "Information Technologies." The research questions focus on students' perceived digital competencies for teaching and learning prior to and following their training, as well as differences within and between the two groups. Participants included 44 Ultra-Orthodox students (all female) and 117 secular students (5 male and 112 female). The tool developed for this study included a questionnaire dealing with perceived proficiency in using ICT before and after the course and addressing their technological and pedagogical self-efficacy as well as their perceived importance of the course for their role as students and as future teachers.

According to findings, differences between the two groups were identified in perceived proficiency in using ICT before and after the course within and between groups: proficiency was significantly higher in 5 of 6 platforms among the secular group. Proficiency using Word was the highest, and the only platform in which no significant differences were identified between Ultra-Orthodox and secular students. We examined correlation between proficiency and students' age in both groups prior to the course. In the Ultra-Orthodox group correlations were significant between age and proficiency using all digital platforms, i.e., the older the participants – the less proficient they perceived themselves prior to the course.

Regarding their technological and pedagogical self-efficacy, differences were also identified. Perceived proficiency was higher in most digital platforms in both Ultra-Orthodox and secular groups. However, no differences were found between groups in their perceptions regarding their proficiency in using the platforms studied in the course at the end of the course. Students were asked regarding their sense of confidence in their ability to cope with digital platforms unfamiliar to them. In both groups average was high, but no differences were found between groups. No correlations were found between age and proficiency using digital platforms within both groups after the course. The average was high for both groups regarding their perceptions of the importance of the course for their training as students as well as for their teaching as teachers. Ultra-Orthodox students perceived the importance of the course as higher than their peers in the secular group. When examining correlation between age and perceived importance of the course "Information Technologies" for training and teaching, we found a correlation between age and perceived importance of studying the course in the Ultra-Orthodox group, i.e., the older the students, the higher was their perceived importance of the course for training. Findings show fundamental impact of the course among Ultra-Orthodox participants in technological and pedagogical aspects."

Kabudi, T. (2019, March). Designed theoretical framework for a virtual university implementation in an African environment: A systematic review paper. In L. Gomez Chova, A. Lopez Martinez, & I. Candel Torres (Eds.), *INTED 2019: Proceedings of 13th International Technology, Education and Development Conference* (pp. 3637–3646). https://doi.org/10.21125/inted.2019.0935

Abstract: "In the past two decades, the concept of establishing a virtual university in Africa was seen as important (Oketch, 2015). This was because virtual university has been revealed in

other continents as being effective and efficient way to support university students in the learning process through the use of Information and Communication Technology (ICT). According to Ryan, Scott, Freeman and Patel (2013), a virtual university does not have a single physical campus; this university is connected by networks and other technological tools such as video conferencing, voice boards, virtual worlds and Virtual Learning Environment (VLE). This kind of modernized education institution is seen quite beneficial to African traditional universities. Some African countries had shown interest in introducing a virtual university. This is evidenced in the African Virtual University Project of the World Bank has implemented in 21 African countries (Oketch, 2015). However, the delivery of degrees and diploma courses in the university faced with difficulties that forced some organisations such as Royal Melbourne Institute of Technology to withdraw from the partnership. In addition to that, main stakeholders failed to get a clear understanding about what exact tools and technologies may be suitable for creating a suitable virtual university in an African environment. There is also paucity of literature on frameworks that may guide well the implementation of virtual university in an African environment. Therefore, there is a need to research on the above mentioned challenges and literature paucity. The main research question that guided this study was: What are the key factors of a framework that support implementation and an effective teaching and learning environment in a virtual university? The paper presents an interpretive theoretical framework which defines distinctive characteristics, types and categories that will support effective implementation of a virtual university in an African environment. A systematic approach was embraced to establish a rigorous literature review that has grounded this study. The questions were used to correctly identify the source materials and relevant studies. The research aimed specifically at investigating various current frameworks on tools and technologies to support a virtual university. It was seen that most current frameworks do not sufficiently consider cultural-pedagogical constructs in African countries. Thus, the frameworks are not adequate for establishing virtual university in an African environment. The researcher modified and expanded on the existing frameworks to propose a framework that will be suitable. The paper proposes a framework that comprises four main factors that help implement a virtual university in Africa. The framework shows the distinctive characteristics and categories that are suitable to create and support the various teaching and learning activities in a virtual university. The factors include Tools and technological infrastructure; Pedagogical and learner specific issues; Evaluation; and the African environment. These four main categories with its sub themes are considered as pillars of a virtual university implementation. The research is relevant as it provides insight into considering the appropriate teaching strategies, learning paradigms, tools and technologies in support of implementing a virtual university in an African environment."

Martins, A. R., & Oliveira, L. R. (2019, March). Teachers' experiences and practices with game-based learning. In L. Gomez Chova, A. Lopez Martinez, & I. Candel Torres (Eds.), *INTED 2019: Proceedings of 13ᵗʰ International Technology, Education and Development Conference* (pp. 8575–8583). https://doi.org/10.21125/inted.2019.2139

Abstract: "Game-based learning can support effective pedagogical approaches that can only enter schools if teachers are on-board with it, and are given the necessary time, training and

tools. This research examines teachers' perceptions about educational games and game design, collected during a continuous professional development course.

Participants are elementary and middle school teachers from a group of schools located in the northern region of Portugal. Twenty teachers registered initially for the course, eleven of which finished the training program. Data from pre-and post-surveys' written responses is analysed using descriptive statistics. The study investigates teachers' familiarity with video games, attitudes toward game-based learning, and perceptions in terms of technological, pedagogical and content knowledge.

Lack of technological knowledge and resources, as well as insufficient time, are the most common barriers perceived by teachers, limiting the implementation of game-based learning approaches in schools. The training course impacted positively teachers' self-confidence in technological knowledge and technological pedagogical knowledge.

The data collected is relevant to guide the design of training programs and strategies to support and scaffold teachers' knowledge and practical application of game-based learning."

Ngcapu, S., Mji, A., & Simelane-Mnisi, S. (2018, November). Exploring the student teachers' technological knowledge for ICTs integration. European Conference on e-Learning. In Kidmore End (Ed.), *European Conference on e-Learning* (pp. 686–693). Retrieved from https://search.proquest.com/openview/ecd333e91824a962efc3c3831c0e3355/1?pq-origsite=gscholar&cbl=1796419

Abstract: "Globally, the lackadaisical pace of the adoption of technology for teaching and learning in education has led to numerous evaluations of pre-service training programmes. The technology integration training programmes are observed as the attributes to the inefficacy of the pre-service teachers to integrate technology into learning. It is reported that the integration of technology is still low in the higher education as some institutions, are still using traditional ways of teaching and learning. This is the case at a study University of technology. For pre-service teachers to effectively teach with technology, they must possess three bases of knowledge as portrayed in Technological Pedagogical and Content Knowledge (TPACK) as a theoretical framework for the knowledge base. It is opined that TPACK assists in the technology integration in a specific educational context that is aligned to the content, pedagogy and the potential of technology. This paper will report on Technological knowledge of the TPACK framework. Technology knowledge is a critical knowledge that is required by pre-service teachers because it plays a major role. Technological Knowledge includes being able to choose and use technology in context. The participants were 230 pre-service teachers in the School of Education in the University of Technology (UoT) in South Africa. They were selected randomly from three departments. Quantitative data was collected using adapted TPACK instrument focusing on item for the questions used in: TK1_19; TK2_20; TK3_12; TK4_12; TK5_4 and TK6_25. To determine whether there was a difference between males and females with respect to technology knowledge, an independent samples t-test was computed. Furthermore, to establish whether any differences would be established in terms of Technical Knowledge scores with respect to the departments participants were from, a one-way analysis of variance (ANOVA) was computed. In addition, a Tukey post-hoc analysis was carried out to establish which departments' scores were different. The results show that the t-test revealed a

statistically significant difference (t (228) = 3.910, p < .05). It may be concluded that in this paper females possess a higher level of technical knowledge than males. A further study is recommended with all the subscale of the TPACK with a similar group of participants."

Ravanelli, F. (2019, June). The digital dimension in university traineeship: An opportunity to build innovative professional teaching competencies. In Pixel (Ed.), *Conference Proceedings of the 9th Edition of The Future of Education*. Retrieved from https://conference.pixel-online.net/FOE/files/foe/ed0009/FP/5956-TPD4085-FP-FOE9.pdf

Abstract: "The article aims to illustrate the experiences of using digital technology in the internship of future teachers at the University of Bolzano -Faculty of Education. In the Italian National Digital School Plan (2015) it is stressed that digital training is necessary not so much from the IT point of view, but as a necessary ground for the development of competences oriented towards innovation in teaching practice. As the National Teaching Training Plan (2016) –NTTP-states, universities are asked to build, in alliance with schools, the real spaces for the evolution of professional knowledge that should include an updated perspective of the basic skills of the teaching profession (pedagogical-didactic-relational) effectively supported by the use of digital technology, according to the model TPACK (Technology, Pedagogy and Content Knowledge). University of Bolzano is working, in some courses, toward these perspective, however an important part of this pedagogical-didactic innovation is played in the traineeship. Since 2016, the students of Faculty of Education have been using an e-portfolio to document and reflect on their personal and professional path and during the various indirect training workshops they share practices and reflections through digital and multimedial artifacts in a digital social platform. This way, the internship is configured as a real playground for the development of those professional skills aimed to innovate teaching practices that characterize the guidelines of NDS Prequest, where it is highlighted that digital competence helps to build the logic of educational innovation."

Riandi, R., Apriliana, V., & Purwianingsih, W. (2018, December). The analysis of 21st century teachers' ability in technological pedagogical content knowledge. *ICEI 2018: Proceedings of the 2nd International Conference on Education Innovation* (pp. 275–278). https://doi.org/10.2991/icei-18.2018.60

Abstract: "This study aimed to analyze how the ability of [a] biology teachers' forum (called as MGMP Biology teachers) on the 21st century TPCK. This case study was conducted on 10 MGMP Biology teachers from different schools as the participants. The data were collected by using a questionnaire. The data analysis was conducted descriptively based on 7 components in TPCK of the 21st century: Pedagogical Knowledge (PK), Content Knowledge (CK), Technological Knowledge (TK), Pedagogical Content Knowledge (PCK), Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK) and Technological Pedagogical Content Knowledge (TPCK). The results showed that the mean PK (2.90), CK (2.40), TK (2.25), PCK (1.92), TPK (1.93) and TPACK (1.97) TCK with averages (1.73) was categorized as very less ability. This

result shows that the ability of 21st century TPCK of the teachers still needs to be improved on the aspects of content mastery, pedagogy and technology."

Serrado Bayes, A., & Pavon Iglesias, A. (2019, March). Teacher training for professional development on modern education in science for industry 4.0. In L. Gomez Chova, A. Lopez Martinez, & I. Candel Torres (Eds.), *INTED 2019: Proceedings of 13th International Technology, Education and Development Conference* (pp. 4757–4766). https://doi.org/10.21125/inted.2019.1185

Abstract: "Modern Education in Science for Industry 4.0 (MESI 4.0) is an ERASMUS+ KA229 Action for School Exchange Partnership co-funded by the European Union. The action wants to increase students' interest (ages 15 to 19) in natural sciences and math, in general, and in industry, in particular. During the project students will learn about the concepts that will push global manufactures to a new level of optimization and productivity. Moreover, the students will develop the necessary skills to critically postulate how this Industry 4.0 will benefit the sustainability of the Earth. The knowledge and methodology needed to acquire these new concepts of Industry 4.0 contrast with the traditional teaching and learning approaches that they continue to dominate in natural science and mathematics. Nevertheless, modern technologies could allow teachers the opportunity to better diversify their teaching and learning approaches by including visualizations, demonstrations and exercises that are closely linked to real-life examples about Industry 4.0. The use of these modern technologies could be also an opportunity for teachers' professional development through the deliberate dialogue about modern education in Science, Technology, Engineering and Mathematics (STEM) and Industry 4.0.

A teacher training course was designed under these theoretical principles about what modern education in science for Industry 4.0 means. The teacher training used a peer-to-peer methodology to enhance teachers' use of new software for communication (e.g. Webinars), organize and share information (Google Drive), improve blended learning and teaching (e.g. Edmodo), and show software for measurements (Vernier). The peer-to-peer methodology challenged the discussion about how to improve students' presentation and communication skills in a foreign language. The discussion about how to improve these communication skills will be critical for challenging students' discussion about the pros and cons of Industry 4.0.

In this paper, we present the first insights about the benefits of this teacher training expressed by the eighteen teachers of four different countries (Czech Republic, Spain, Germany and Lithuania) participating in the meeting. We understand this benefits in relation to their understanding about the Technological, Pedagogical and Content Knowledge that they could use to design activities and materials for challenging students learning in Industry 4.0."

Terbeek, L., Cremer, M., & van Klaveren, C. B. P. J. (2019, March). The power of blended learning: What we know and what we need to know. In L. Gomez Chova, A. Lopez Martinez, & I. Candel Torres (Eds.), *INTED 2019: Proceedings of 13th International Technology, Education and Development Conference* (pp. 2459–2469). https://doi.org/10.21125/inted.2019.0675

Abstract: "Blended learning, in which online and face-to-face learning activities are combined, is central to educational innovation within a rapidly growing number of educational institutions worldwide. The popularity of blended learning is somewhat remarkable, because it is premised on the belief it yields better educational outcomes, not on rigorous scientific evidence. In this study we discuss the findings of our review of empirical literature on blended learning and its implications of the described interventions on the measured outcomes; efficiency, effectiveness, motivation and costs. We determine what we know about blended learning and based on this what we need to know about it by systematically determining similarities and differences from three perspectives. Firstly, we determine the effects of the, so characteristic for blended learning use of learning technology, on measured outcomes of the interventions. Secondly, by distinguishing three intervention components; teaching method, learning activity and learning technology, we determine intervention types. This classification allows us to identify comparable studies. Thirdly, we use the Community of Inquiry (CoI) framework, our extensive version of the associated code template of the CoI framework and the validated CoI survey to review the comparable studies in more detail. This study has added value in several regards, it is the first one to conceptualize and compare blended learning interventions by using our expanded version of the original Community of Inquiry (CoI) framework code template, where we add a careful distinction between online and face-to-face activities related to the categories of the teaching and social presence. As a result we offer an overview that contributes substantially to the understanding of the dynamic and complex phenomenon blended learning. Based on our review findings we identify gaps in existing blended learning research, which allows us to provide recommendations and guidelines for future systematic blended learning research, that appears to be very urgent. Beyond its scientific contribution, this review is informative for educational technologists, teachers, policy makers, and directors of education."

Utami, P., Pahlevi, F. R., Santoso, D., Fajaryat, N., Destiana, B., & Ismail, M. E. (2019). Android-based applications on teaching skills based on TPACK analysis. *Proceedings of the International Conference on Technology and Vocational Teacher*. https://doi.org/10.1088/1757-899x/535/1/012009

Abstract: "Teaching skills learned in micro-teaching are important competencies in the learning management. Dependence of other parties, both lecturers and colleagues teaching during the assessment process of teaching practice and lack of media that integrates the concept of material, examples, and practices are obstacles in mastering teaching skills. This article describes the specifications needed of an Android-based learning tool (media) for microteaching ("Microteaching") courses and analyzes the performance of these learning media. The development phase begins with Analysis, Design, Development, and Evaluation. The results of the analysis referring to TPACK and the design showed that the specifications of the Android-based media consisted of two main menus namely material (containing various multimedia elements) and assessment (besides text-based assessment also contained speech recognition elements). The performance of "Microteaching" in functionality is 100% successful, while the feasibility test at the evaluation stage not only for media experts, but material experts and users indicates that the media is suitable for use. Furthermore, results of the assessment

show that the media is able to depend on the assessment, except from the aspect of verbal aspects. Integration of learning concept material through mind maps, technical examples related to verbal teaching skills and videos to provide concrete description of how to teach (both verbal and non-verbal).”

Xu, S., Zhu, S., & Tang, M. (2018, October). A research on the present situation and strategies of pre-service teachers' TPACK competence. *ITME 2018: Proceedings of the 9th International Conference on Information Technology in Medicine and Education*. https://doi.org/10.1109/itme.2018.00085

Abstract: “The purpose of this paper is to explore the present situation of pre-service teachers' TPACK competence, analyze the effect of pre-service teachers TPACK competence by demographic variables (gender, subject and background), find the reasons for situation analysis and give the corresponding strategy. In this study, 97 pre-service teachers of a normal university in Hubei province of China were selected as the samples, and a quantitative approach was implemented. The results showed that the pre-service teachers had good TPACK competence. Through descriptive analysis, the Ethics dimension was the highest and the Proficiency dimension was the lowest in all the dimensions of TPACK competence. Through ANOVA analysis, it revealed that gender, subject and background had no significant effect on the pre-service teachers' TPACK competence. Finally, some strategies are proposed to improve pre-service teachers' TPACK competence by the findings.”

Zaritsky, M. (2018, December). Bringing technology into the classroom: One iteration at a time. In S. Kourieos (Ed.), *CyTEA 2018 Conference Proceedings: Embracing Change in ELT: Challenges and Perspectives* (pp. 24-28). Retrieved from https://cytea.weebly.com/uploads/1/0/8/5/108581733/proceedings_annual_conference_2018__1_-final_2.pdf

Excerpt: “This design-based research explores the professional growth of inservice English teachers in Israel. More specifically, it aims to understand the factors which contribute to teacher professional development in terms of pedagogically meaningful incorporation of technology within teaching."

5. TPACK Newsletter Suggested Citation

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

Harris, J., & Wildman, A. (Eds.). (2019, November 10). TPACK newsletter issue #42: November 2019 [Electronic mailing list message]. Retrieved from http://bit.ly/TPACKNewslettersArchive

6. Learning and Doing More with TPACK

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

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

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

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

Standard End-Matter

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

- Judi & Amelia

…for the SITE TPACK SIG leadership:

Yi Jin,	Co-Chair, Sonoma State University
Daniel Mourlam,	Co-Chair, University of South Dakota
Teresa Foulger,	Sit-Upon Chair, Arizona State University
Mamta Shah,	Library Bookcase Chair, Drexel University
Josh Rosenberg,	Camping Chair, University of Tennessee

Petra Fisser,	Red-Blue Chair, SLO Expertise Center, National Curriculum Development
Candace Figg,	Rocking Chair, Brock University
Mark Hofer,	Sedan Chair, William & Mary School of Education
Judi Harris,	Wing Chair, William & Mary School of Education
Mario Kelly,	Futon, City University of New York
Matt Koehler,	Chaise Lounge, Michigan State University
Punya Mishra,	Recliner, Arizona State University