Análisis del Conocimiento del Contenido Pedagógico Tecnológico (TPCK) en Educación Superior

Analysis of Technological Pedagogical Content Knowledge (TPCK) in Higher Education

Rodrigo Tovar Viera
Universidad Técnica de Cotopaxi
Latacunga, Ecuador
rodrigo.tovar@utc.edu.ec
Orcid: 0000-0002-5960-3020

David Abrajan Arias
Universidad Técnica de Cotopaxi
Latacunga, Ecuador
david.abrajan@utc.edu.ec
Orcid: 0000-0002-9595-678X

Johana Muso Chango
Universidad Técnica de Cotopaxi
Latacunga, Ecuador
johana.muso@utc.edu.ec
Orcid: 0000-0003-3997-784X

Resumen— Estudios sobre las Tecnologías de la Información y la Comunicación reflejan una amplia integración de las herramientas digitales en la enseñanza de idiomas. Uno de los aspectos clave de las tecnologías digitales es que tienen potencialidades y limitaciones a la hora de diseñar actividades de aprendizaje basadas en la tecnología, resultando en prácticas tecnológicas en el aula en la enseñanza de idiomas y originando una nueva área de investigación para profesionales e investigadores. Este estudio explora las competencias tecnológicas y las percepciones de los profesores de idiomas sobre el uso de la tecnología, pedagogía, y contenido en sus clases. Se aplicó una encuesta para recopilar información sobre el uso de herramientas tecnológicas, la integración de la tecnología, la pedagogía y los contenidos en la enseñanza del inglés, y el conocimiento sobre sus componentes. Los resultados informan que, aunque los docentes aplican tecnología en sus clases y poseen conocimientos de tecnología digital, a menudo omiten posibles actividades de aprendizaje. Es decir, los profesores muestran un bajo nivel en el dominio del conocimiento relacionado con la tecnología. Dado que los profesores de inglés informan que poseen dificultades al integrar el modelo de Contenido Pedagógico Tecnológico para planificar hábilmente instrucciones lingüísticas ricas en tecnología, los resultados de este estudio sugieren que este modelo es necesario en los programas de capacitación. Esto permite que los profesores encuentren oportunidades prácticas para la integración de la tecnología en sus prácticas docentes. Se espera que los resultados de este estudio originen implicaciones pedagógicas y aplicaciones para futuras investigaciones.

Abstract— Information Communication Technology research reflects the degree of integration of digital tools in language teaching. One of the key aspects to digital technologies is that certain technologies have affordances and constraints when designing technology-based learning activities, resulting in classroom technology practices in teaching languages creating a new research area for practitioners and researchers. The present study investigates English teachers' technological competences and perceptions of using technology, pedagogy, and content in their language classrooms. A survey was applied to gather information about the use of technological tools, the integration of technology, pedagogy, and content in teaching English as well as knowledge about their components. Results revealed that although teachers applied technology in lessons and had knowledge of digital technology, potential learning activities were often overlooked. Teachers were not sufficiently skilled in technology-related knowledge domain. Since English teachers reported difficulty integrating the Technological Pedagogical Content Knowledge framework to plan technology-rich language instructions skillfully, research outcomes suggest that such a framework is needed in training programs. This affords teachers practical opportunities integrate technology into their classroom teaching practices. Ideally, research findings will uncover pedagogical implications and applications for further research.

Palabras Clave: Contenido, enseñanza, idiomas, pedagogía, tecnología.

Keywords: Content, languages, pedagogy, technology, teaching.

I. INTRODUCTION

Technology has improved the administration and organization of general education, particularly in language teaching and learning. With technological advancements teachers and language learners, particularly Ecuadorians, are experiencing new language teaching and learning scenarios. Ten to twenty years ago, technology did not influence language teaching and language learning as it does today. To get positive results and learners' enduring understanding, teachers and students must learn how to use technology productively. To an extent, language instructors require a certain level of technological knowledge to develop their professional development and learn new skills and knowledge [1].

Technological Pedagogical and Content Knowledge (TPCK) [2] has been developed from the Knowledge of Pedagogical Content model [3], which states that the interconnection between Content Knowledge and Pedagogical Knowledge produces effective language teaching and learning. The TPCK framework has been designed to focus on teachers' use of technology with pedagogy and content to effectively develop language teaching strategies. This framework has generated changes in society and allows teachers and school administrators to propose new teaching methods by incorporating contemporary methodologies and diminishing traditional ones.

As teaching and learning evolve, English teachers must use new methods and technological tools for enhanced language teaching in the digital era. The use of technology is essential in learning a foreign language [4] and [5] although the technology is already in student pockets, mounted on walls, and in nearly all electronic device in the back of classrooms [6], many teachers often overlook how to leverage and integrate it as a didactic resource for their language teaching and language instructions. Often English teachers are challenged in developing technological competencies when using or teaching with technology [7]. One reason may be that teachers have not become digitally competent and hesitate using new technological resources. Another reason may be that teachers do not know how to access suitable methodologies to incorporate technology in the classroom [8]. English teachers cannot stay indifferent to the changes that happen in the educational panorama [9].

When examining teacher development in related knowledge domains of TPCK framework, it was observed in [10] that though teachers applied technology in their lessons, they did not develop potential activities for learning as they were not proficient in the technology-related knowledge domain. In [2], following the notions of [3] and the central idea of blending content and pedagogy to increase the understanding of how particular topics or problems are arranged and adapted to the diverse interests and various levels of learners' abilities, it is stated that "thoughtful pedagogical uses of technology require the development of a complex, situated form of knowledge called Technological Pedagogical Content Knowledge (TPCK)" (p.1017). According to [2], this model allows the incorporation of technological resources in the function of the different types of knowledge that intervene in the

design of digital educational resources: content, pedagogy, and technology. It also addressed how the dynamic integration among content, pedagogy, and the incoming technology generates the seven domains of the framework, namely Content Knowledge (CK), Pedagogical Knowledge (PK), Technological Knowledge (TK), Pedagogical content knowledge (PK), Technological Content Knowledge (TCK), Pedagogical Technological Knowledge (TPK), Technology, pedagogy, and content knowledge (TPCK). Such a meaningful and efficient way of teaching content with technology goes beyond the isolated knowledge of the TPCK's three key domains. It addresses the way the interconnection of these domains and different contextual communicative situations, construct effective language scenarios for successful knowledge transmission.

Despite the broad potential of Information and Communication Technology (ICT), the TPCK framework has not been extensively applied in teaching languages, particularly in Ecuador, except with selective works [11]-[16] reported in the last five years. The effective use of ICTs to promote social inclusion and development in education and language teaching is one of the key challenges today. Consequently, it is not surprising that when someone talks about the use of technology in the language classroom, the first word that comes to mind is computer technology [17]. It is essential to understand how computers help develop target languages and that computers alone cannot develop language learners' skills. Language instructors must integrate proper methodologies to reinforce learners' linguistic competences [18] and encourage them to find appropriate computer technology activities [19]. Then, [20] regarding the ICTs' usage, highlights that we need technology in every classroom and in the hand of every student and teacher, because it is the pen-and-paper today's digital era, and the lens through which we experience much of our world. However, the challenge is how to optimize and use it effectively in the classroom.

Nonetheless, the present research investigates EFL language teachers' technological competences and perceptions of using the technology, pedagogy, and content in their language classroom. The research questions that lead this study are: What technological tools are used for academic purposes? What are the teachers' perceptions of integrating technology, pedagogy and content in language teaching? What do teachers know about the TPCK components?

II. METHODOLOGY

The research study is descriptive in design with a quantitative, result-oriented approach. It adopts the assessment instrument from [21] to collect information about a) the use of technological tools to communicate with students, b) knowledge of integrating technology, pedagogy, and content in their teaching practices, and c) knowledge about TPCK components.

A. Participants

Participants in this research study included sixteen in-service English language instructors from the Teaching

Staff of the Language Center at the Technical University of Cotopaxi. The participants were 56.3% female and 43.7% male. The majority (53%) ranged a teaching experience from 6 to 10 years, and the total number of participants has a master's degree. Thus, 19% of participants has a MA in teaching English, 75% in Education, and 6% in technology for teaching and management. Additionally, 69% possess a Higher Diploma in English as a Second/Foreign Language.

B. Data collection Procedure

For the nature of the population, the study is exploratory, diagnostic, and descriptive. The data was collected in the period of March-August 2019 through the adapted TPCK questionnaire [21]. The questionnaire was applied to 16 in-service English teachers, and it was submitted to their e-mail addresses and via WhatsApp to gather in-service teachers' TPCK perceptions and their technological competences. Excel Analysis ToolPack was employed for quantitative data processing analyses. Under a descriptive scope, the study seeks to measure information collected by running a commentary analysis on the phenomenon under study [22].

C. Survey design

The survey design involved reviewing relevant literature on numerous instruments already being used for assessing technology use in educational settings. Most of these instruments focused on technological resources, technology skills, advantages and disadvantages of technology, teacher attitudes and technology support. The instrument was developed according to the conceptualizations about pedagogy and content knowledge and how technology is increasingly related to language teaching and learning.

D. Validity of the Instrument

Five MA English teachers gauged the validity and reliability of the questionnaire. The pilot study results suggest modifying four items of the questionnaire, as these were not accurate and not connected with the objective and research questions. Later, the questionnaire with some amendments were submitted for final evaluation so that it was seen as a reliable and valid instrument —with Cronbach's Alpha internal consistency of 0.982 that allowed researchers to diagnose and describe EFL teachers' technological, pedagogical, content knowledge. The survey consisted of two sections. The first part inquired information about the use of technological tools to communicate with students for academic purpose. The second part contained 35 items for measuring TPCK components (5 TK items, 5 CK items, 5 PK items, 5 PCK items, 5 TCK items, 5 TPK items, and 5 TPACK items) in EFL teachers. The 35 questions are based on a Likert scale level: (1=strongly disagree; 2 =disagree; 3=neutral=4; agree=5; strongly agree =6).

III. RESULTS AND DISCUSSION

Examining technological tools teachers used to communicate for academic purposes is a must. As shown in Fig. 1, participants reported that the average frequency

of using WhatsApp (as text messages and video calls) was 100% applied throughout their teaching practices. That is, they used WhatsApp (M=10) more often to communicate with their students, followed by educational platforms and e-mail addresses (M=6.3), respectively. Concerning real-time communication between several users whose computers are connected to a network or so-called Chats (M=5.0), were the third technological tool used to keep contact between teachers and students. In contrast, Blogs (M=1.3) were considered the least used for academic purposes among EFL teachers.
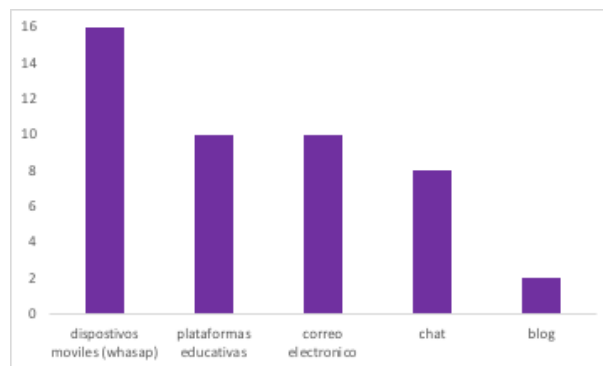

Fig. 1 Use of technological tools

Data on Fig. 2 illustrates teachers' knowledge of integrating technology, pedagogy, and content in their teaching practices. Data could be quite revealing in several ways. First, over half of those surveyed, 56.25%, can integrate appropriate methods and technologies and use strategies to effectively teach English. A minority of participants (12.5%) indicated that they have difficulty selecting strategies and technologies. While 62.5% of those interviewed indicated that they could teach combining the content, pedagogical and technological knowledge and applying strategies and computer applications; a minority of participants (12.5%) indicated that they successfully combined the TPCK model. While 56.25% of those interviewed indicated that they could take a leadership role among their colleagues in integrating technological, pedagogical, and content knowledge while two English teachers have difficulty integrating TPC knowledge [23]. See TABLE I

TABLE I
NEGATIVE CORRELATION BETWEEN VARIABLES

	Technology	Pedagogy	Content
Technology	1		
Pedagogy	-0.3113514	1	
Content	0.11994605	-0.2353528	1

When analyzing the isolated question about the integration of technology, pedagogy, and content knowledge into their lesson plans, the total number of respondents (100%) indicated they could integrate the framework within their teaching practices. Nonetheless, the items related to the effective integration of technologies and the relationships of technological, pedagogical, and content knowledge in Fig. 2, reveals a negative correlation between the variables (see TABLE I). The possible reason

could be that their pedagogical knowledge is not according to their technological and content knowledge (see Fig. 5). Accordingly, Koehler *et al.* highlight that both the mastery of content to be taught and how such content is practically connected with technology, by integrating cognitive and theories of language learning are crucial to generate enduring understanding.
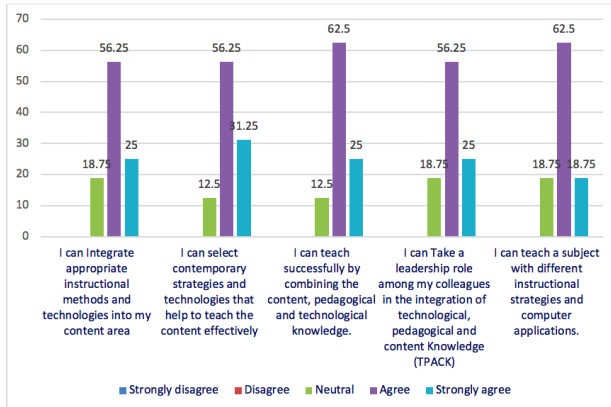

Fig. 2 Technological, pedagogical, and content knowledge

Concerning knowledge about the TPCK components, 100% of participants expressed that they knowledgeable about technological component. As can be seen from the Fig. 3 (below), over half of those surveyed (56.25%) reported frequently using technology such as websites, blogs, and wikis. A minority of 18.75% of participants indicated that they could learn technology quickly, and only 12.5 % mentioned that keep up with important technologies. Whereas, 18.75% of those interviewed indicated using technologies to teach English and know several new technology websites, for instance, web 2.0, blogs, and wikis. There is evidence that the majority of the English teachers know about technology. However, 25% of the English instructors reported limitations to solving digital and technical problems and unaware of several websites, blogs, wikis, etc. Additionally, 6.25% of the respondents indicated they cannot solve digital and technical issues in the use computer – mediated as a source for learning. In general, data showed that teachers struggled with integrating technology into their language teaching practices. These results are in line with [24] and [25], who pointed out lower technological competence levels in language instructors.
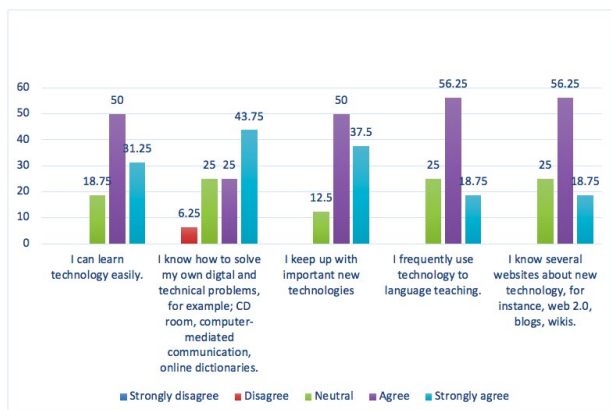

Fig. 3 Technological knowledge

The results regarding content knowledge reflect that 62.5% English teachers are familiar with the linguistic and cultural background of the English language community, and recent research in the English language. Thus, 56.25% of the surveyed informed having various ways and strategies to teach English and to lead with student's queries and difficulties shown into the teaching-learning process. It is observed that most English teachers are familiar with content knowledge and can solve students' questions, nevertheless, only 6.25% of them know how to apply English content-related domains in the real-life learning situations. Even though teachers acknowledge mastering the content of the English language, there are still limitations to know how such a content in English can be applied in enduring and meaningful learning activities via the use of technology and the implementation of useful language learning activities to improve learners' linguistic and communicative competences.
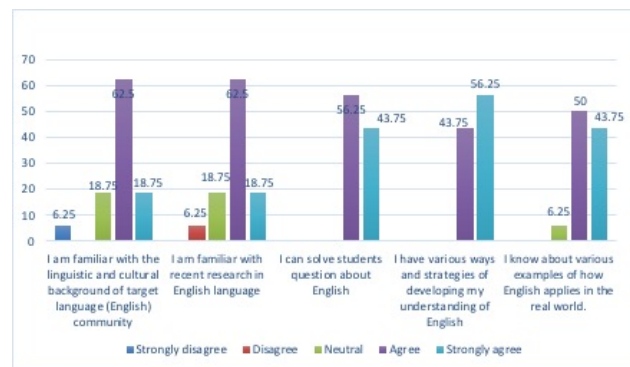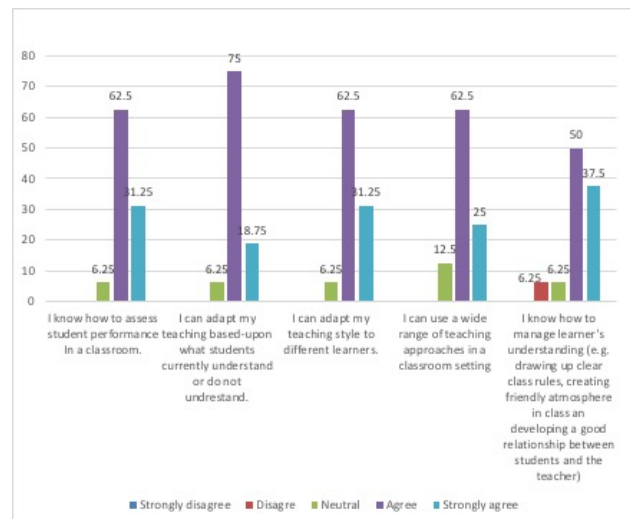

Fig. 4 Content knowledge

Fig. 5 Pedagogical knowledge

Regarding pedagogical knowledge, 62.5 % of language instructors know how to assess student performance, adapt their teaching style, and employ a wide range of teaching approaches in a classroom setting; 18.75% have difficulties adapting their teaching style and the curriculum in students' performance within the learning stages. Over half surveyed know how to manage learners' understanding, creating a friendly atmosphere in class, and developing a good relationship between students and the teacher. In contrast, 18.75% have difficulty managing learners' understanding and cannot use a wide range of teaching

approaches in a classroom environment. It evident that English teachers have enough knowledge regarding practical pedagogical knowledge while a minority of participants (6.25%) bore limitations handling students' comprehension due to their inability to adjust their teaching style to learners' individual differences. This is in connection with the research outcomes highlighted in [23].

In Fig. 6, the summary statistics for teachers' pedagogical content knowledge shows that the majority of respondents felt that they guide students' critical thinking properly. Thus, 81.25% can select practical teaching approaches to monitor student thinking and learning in English, and 68.75% familiar with technology and can use it to teach English, but 18.75% show limited knowledge about digital technology and how to use it in their classrooms. From these results, we can infer that most English teachers have a solid knowledge of pedagogy and content and seem capable to select appropriate and effective teaching strategies for the content area. However, difficulties exist in applying varying teaching approaches either in their lesson plans or their practices. It can thus be suggested that pedagogical uses require the development of a complex and situated form of knowledge when integrating teaching with technology [3].
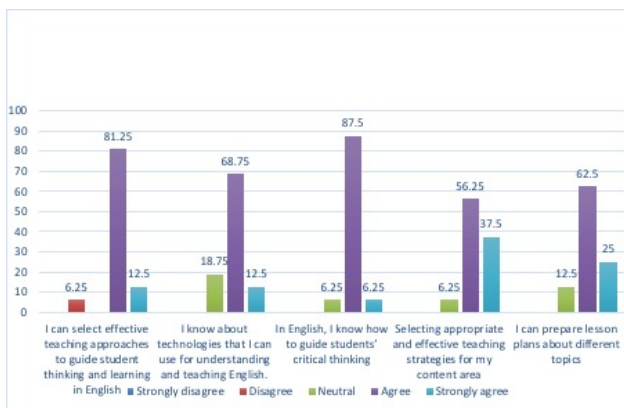

Fig. 6 Pedagogical content knowledge

Regarding technological pedagogical knowledge (see Fig. 7), over half of the participants (62.5%) can choose technologies to enhance their teaching approach and think critically when using and applying technology in their classroom. Nonetheless, 6.25% of them indicated an average understanding of how to adopt technology in their teaching activities. These results are in line with those of [25] who reported difficulties in using technology in language classrooms. While 43.75% of English teachers state they know how to use technology as a teaching tool for students problem-solving, 25% know how to use computer applications to support student learning. A further analysis between items in Fig. 2 and Fig. 3 revealed that although teachers showed positive occurrences of using technology and pedagogy in their classes, they had limited confidence to technology integration, that is, there was no significant difference at the p=0.05 level, among items. This parallel analysis is in line with those who discovered less self-confidence in English teachers at using technology for academic purposes in their classroom [20].
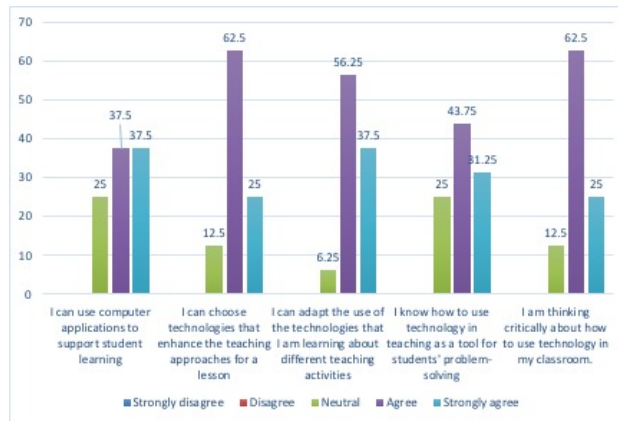

Fig. 7 Technological pedagogical knowledge

The results regarding technological content knowledge in Fig. 8 (below) set out that 50% of the language instructors understand about websites and can prepare lesson plans using online materials. Meanwhile, 56.25% know technology applications and apply them to illustrate difficult contents in English. Although English teachers recognize their technological and content knowledge, they struggled difficulties when selecting effective teaching approaches to guide students' critical thinking and learning in English lessons. A minority of participants reported having advanced knowledge in the use of digital tools to language teaching but had limitations in understanding how to use technology in academic setting. On the other hand, while 56.25% of them can select appropriate and effective teaching strategies for their disciplinary area, 62.5% can prepare lesson plans about different topics. The results can determine that English teachers have enough knowledge regarding practical teaching approaches to guide students' critical thinking and learning. Nevertheless, a minimum percentage (6.25%) cannot select and apply effective teaching strategies for developing the English language. These results corroborate the findings of a much of the previous work in [11],[12] and [13] that found lack of digital competence and limitations with integrating technological tools in language teaching.
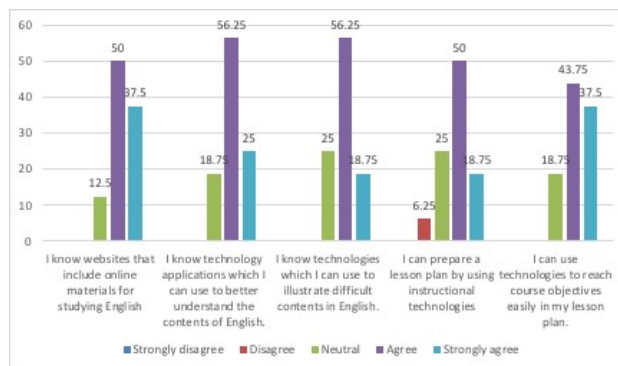

Fig. 8 Technological content knowledge

Although most revealed positive beliefs to the TPCK framework, it does not mean that all teachers had the proper knowledge and competence in the related domains. Accordingly, [23] suggests using the TPCK framework prior to gaining knowledge of what makes concepts difficult or easy to learn and how technology can positively

guide building on existing knowledge and teaching materials.

IV. CONCLUSIONS

Research on educational practices reflects the extensive integration of digital tools in language teaching [26]-[30]. Overall, the study provides a description of English teachers' knowledge about classroom technology practices, including pedagogy and content integration with technology in language teaching. Regarding the effectiveness of using technology in the classroom, results suggested that there are still limitations in understanding how digital technology could be integrated; that is, participants are still far behind the effective integration of technology-based environments in language teaching. In general terms, teachers perceived high valuations on their technological knowledge, although they claim skills difficulty in integrating tech-tools and digital applications in the PCK components. A possible explanation for these results may be the lack of familiarity with the technological sub-components of the TPCK framework since they see technology, pedagogy, and content as independent components of each other rather than collaborative components. This could pose unnecessary challenges to teaching practices, in the sense that TK itself cannot determine the quality of knowledge transmission.

Concerning technological skill competencies, teachers showed little confidence in technology integration under the CK to be taught and the PK to be used as well as an inadequate understanding of the TK, TCK, TPK. The self-reported-based questionnaire illustrated the necessity to create opportunities to reinforce and update teachers' technological knowledge to strengthen their digital competencies and to make teaching with technology more efficient and practical. In the present digital era, improving TPCK framework among teaching staff first and then practically is paramount. In other words, they need to first know how to use the domain-specific knowledge in classroom technological practices.

In general, results recommend comprehensive teacher training programs where teachers get feedback on the advantages of technology and what computer programs and applications are suitable for fruitful implementations in language environments and how such tech-tools can provide learners with meaningful and enduring understanding. It can then be concluded that technology should not be used in isolation since acceptable teaching practices depend on teachers' ability to integrate their technological knowledge with pedagogy and content.

Although the current research study is limited by the population being studied and the small scope of data being collected, it provides a useful starting point for understanding participants' beliefs and challenges about their technological competence. Since English teachers reported having difficulty integrating the TPCK framework to plan technology-rich language instructions skillfully, research suggests that such a framework is needed in training programs. Hence, teachers find practical opportunities for technology integration into their classroom teaching practices.

The study is a follow up of previous research from [12] and [13].

REFERENCES

[1] M. J. Koehler, and P. Mishra, TPACK (technological pedagogical content knowledge). In J. Spector (Ed.), The SAGE encyclopedia of educational technology, pp. 783-786. Thousand Oaks, CA: SAGE Publications, Inc, 2015.

[2] P. Mishra, and M. J. Koehler Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record,108(6),1017-1054, 2006.

[3] L. Shulman, Those Who Understand: Knowledge Growth in Teaching. Educational Researcher, 15(2), 4-14, 1986.

[4] K. Luu and J. G. Freeman, An analysis of the relationship between information and communication technology (ICT) and scientific literacy in Canada and Australia. Computers and Education, 56(4), 1072-1082, 2011, http://dx.doi.org/10.1016/j.compedu.2010.11.008

[5] M. Windschitl, Cultivating 21st century skills in science learners: How systems of teacher preparation and professional development will have to evolve. National Academies of Science Workshop on 21st Century Skills, pp.1-23. Washington: Mark Windschitl, University of Washington, 2009.

[6] J. T. Hilton, A case study of the application of SAMR and TPACK for reflection on technology integration into two social studies classrooms. The Social Studies, 107(2), 68-73, 2016, https://doi.org/10.1080/00377996.2015.1124376

[7] R. P. Hechter, and L. A. Vermette, Technology integration in K-12 science classrooms: An analysis of barriers and implications. Themes in Science and Technology Education, 6(2), 73-90, 2013.

[8] M. L. Niess, Preparing teachers to teach science and mathematics with technology: Developing a technological pedagogical content knowledge. Teaching and Teacher Education, 25(5), 509-523, 2015, http://dx.doi.org/10.1016/j.tate.2005.03.006

[9] S. M. Miller, Teacher learning for new times: Repurposing new multimodal literacies and digital video composing for schools. In J. Flood, S.B. Heath, & D. Lapp (Eds.) Handbook of research on teaching literacy through the communicative and visual arts, pp.441-460. New York: International Reading Association/Simon & Schuster Macmillan, 2008.

[10] D. A. Schmidt, E. Baran, A. D. Thompson, P. Mishra, M. J. Koehler, and T. S. Shin, Technological Pedagogical Content Knowledge (TPACK): The Development and Validation of an Assessment Instrument for Preservice Teachers. Journal of Research on Technology in Education, 42(2), 123–149, 2009, https://files.eric.ed.gov/fulltext/EJ868626.pdf

[11] F. Cando, I. Tituaña, B. Bernardo Cando, and Y. Lema, Pedagogical technological competence of content in the areas of language and literature. Congress of science and technology, 13(1), 178- 181, (2018), ESPE, Ecuador.

[12] R. Tovar, M. Chacon, C. Cisneros, and M. Noroña, The TPCK Framework for Technology Integration in Language Teaching. In R. V. M. (CEO) (Ed.), First International Congress of Teacher Education Development-CIDU. Quevedo, Ecuador: Quevedo State Technical University, 2019.

[13] R. Tovar-Viera, Examining Technological Pedagogical Content Knowledge Competencies in In-Service Teachers. Veritas & Research, 1(2), 115-125, 2020, [online] http://revistas.pucesa.edu.ec/ojs/index.php/VR/article/view/13

[14] P. Guerra, El uso de entornos virtuales en el proceso enseñanza aprendizaje de una segunda lengua estudio de caso. Thesis de Maestría en Innovación en Educación. Universidad Andina Simon Bolivar. Quito, Ecuador, 2020.

[15] F. L. Morán, F. E. Morán, and J. Albán, Teacher training and tpack model adaptation. Revista de Ciencias Pedagogicas e innovacion: UPSE, 5 (1), 51-60, 2017, https://bit.ly/36EHMxI

[16] W. Encalada, and J. Sequera, Social Cloud for Information Technology Skills: An Experience with Universities in Ecuador. IEEE Revista Iberoamericana de Tecnologias del Aprendizaje, 12 (2), 76-85, 2017, doi: 10.1109/RITA.2017.2697740

[17] D. H. Brown , Teaching by Principles: An Interactive Approach to Language Pedagogy. New York: Pearson Education, 2001.

[18] M. R. Ahmadi, The impact of motivation on reading comprehension. International Journal of Research in English Education, 2 (1): 1-7, 2017, https://doi.org/10.18869/acadpub.ijree.2.1.1 [Available in] http://ijreeonline.com/browse.php?a_id=35&sid=1&slc_lang=en &ftxt=0

[19] B. Genç İlter, How does technology affect language learning process at an early age? Procedia Social and Behavioral Sciences, 199, 311–316, 2015, https://doi.org/10.1016/j.sbspro.2015.07.552

[20] D. Warlick, Curriculum is dead. 2 cents worth, May 22-2006, [online] http://davidwarlick.com/2cents/2006/5/22/curric

[21] D.A. Schmidt, E. Baran, A.D. Thompson, P. Mishra, M.J. Koehler, T.S. Shin, Technological pedagogical content knowledge (TPACK): The development and validation of an assessment instrument for pre-service teachers. Journal of Research on Technology in Education, 42(2), 123–149, 2009, https://doi.org/10.1080/15391523.2009.10782544

[22] R. Hernández Sampieri, C. Fernández Collado, and M. Baptista Lucio, Metodología de la investigación (Quinta). McGraw-Hill/Interamericana Editores, 2010.

[23] M. J. Koehler, P. Mishra, and K. Yahya, Tracing the development of teacher knowledge in a design seminar: Integrating content, pedagogy and technology. Computers and Education, 49(3), 740-762, 2007, https://doi.org/10.1016/j.compedu.2005.11.012

[24] A. Tanak, Designing TPACK-based course for preparing student teachers to teach science with technological pedagogical content knowledge. Kasetsart Journal of Social Science, 1-7, 2018, https://doi.org/10.1016/j.kjss.2018.07.012

[25] M. H. Lee, and C. C. Tsai, Exploring teachers' perceived self-efficacy and technological pedagogical content knowledge with respect to educational use of the World Wide Web. Instructional Science, 38, 1-21, 2010.

[26] L. L. Taopan, and N. A. Drajati, TPACK Framework: Challenges and Opportunities in EFL Classrooms. Research and Innovation in Language Learning, 3(1), 1-22, 2020.

[27] K. Papin, La contribution des tâches de réalité virtuelle au désir de communiquer en français langue seconde à l'extérieur de la salle de classe à Montréal. Thèse soutenue à l'Université de Montréal, Canada, 2020.

[28] W. Wargadinata, I. Maimunah, S. Ramadhanti, and L. Humaira, Mediated Arabic Language Learning for Arabic Students of Higher Education in COVID-19 Situation. Izdihar Journal of Arabic Language Teaching Linguistics and Literature 3(1), 2020.

[29] T. Miller, K. MacLaren, and H. Xu, Online learning: Practices, perceptions, and technology. Canadian Journal of Learning and Technology/La revue canadienne de l'apprentissage et de la technologie, 46(1), 2020.

[30] S. Khatoony, and M. Nezhadmehr, EFL teachers' challenges in integration of technology for online classrooms during Coronavirus (COVID-19) pandemic in Iran. AJELP: Asian Journal of English Language and Pedagogy, 8, 1-16, 2020.