



Serie *Investigación*

IMPORTANCE OF ICT IN THE TEACHING-LEARNING PROCESS: MIDDLE AND HIGHER EDUCATION STUDIES

Irma Amalia Molina Bernal

Juan Carlos Morales Piñero

Sergio Alejandro Rodríguez Jerez

(Compilers)



**UNIVERSIDAD
SERGIO ARBOLEDA**



Irma Amalia Molina Bernal

Is Director of Research in Education school at the Universidad Sergio Arboleda, Colombia. She is Doctor Honoris Causa in Educational Sciences and has a master's degree in teaching and university research and a master's degree in education and. She has a bachelor's degree in educational administration; Specialist's degree in social management of education, human resources management and university teaching. She is Associate Researcher at Colciencias. Teacher in undergraduate, postgraduate and doctoral degrees. She has been a national and international evaluator, consultant and researcher. With publications in the area and with more than fifteen recognitions for his work in education.

E-mail: irma.molina@usa.edu.co



Juan Carlos Morales Piñero

Is the academic director of the Innovation and Digital Entrepreneurship Department at the Universidad Sergio Arboleda, Colombia. He received his Ph.D. in entrepreneurship, strategy, and business management from Barcelona Autonomous University in Spain. He has served as a research, and professor at different universities in Spain, Venezuela, and Colombia. He has developed research projects in the postal sector, health, education, among others. He has been a speaker in various academic settings and his publications are indexed in international journals. His research interests include public enterprise management, educational policy, and innovation management.

ORCID ID: 0000-0003-2979-4839

E-mail: juancarlos.jp@gmail.com



Sergio Alejandro Rodríguez Jerez

Is Doctor in Society of Knowledge and Action in the Fields of Education, Communication, Rights and New Technologies, International University of La Rioja. PhD candidate in Philosophy, Autonomous University of Barcelona, Spain. Master in Teaching, University of La Salle. Expert in analytics of the knowledge society. Psychologist, Pilot University of Colombia. Active member of the Educational Research group, Sergio Arboleda University (INVEDUSA). Dean, School of Education of the same university, as well as Academic Director of the Dean of Innovation and Digital Development. Collaborator of the Centro Interdipartimentale di Ricerca sulla Comunicazione-CIRCe, University of Turin, Italy. Scientific Director, Colombian Association of Semiotics.

ORCID ID: 0000-0002-3521-0206

E-mail: sergio.rodriguez@usa.edu.co



IMPORTANCE OF ICT IN THE TEACHING-LEARNING PROCESS: MIDDLE AND HIGHER EDUCATION STUDIES

The integration of ICT in education entails several challenges: the first, to diagnose, at a global level, how this process is being carried out in different educational fields. Likewise, another challenge is to analyze what has really been the impact that this integration has had on improving educational quality in Colombia. It is assumed that ICT applied to education generates successful paths to promote both teaching and learning. However, it is necessary to enter the fields of education to corroborate if the previous statement is valid. A third challenge would be to analyze the effect of ICT on the efficiency of educational institutions. In this sense, it is not only necessary to determine the ICT integration process, but also to determine how the same institutions assume responsibility for the digital transformation of education. Another challenge is to validate, experiences carried out using ICT to improve learning processes. Finally, another of the challenges that can be highlighted, and is the most relevant, is the need to assume an ethical stance regarding the management of ICT in education. This book covers each of the challenges with the aim of promoting the processes of innovation and digital transformation of education from a scientific, critical, and above all, ethical perspective.



FONDO DE PUBLICACIONES
UNIVERSIDAD SERGIO ARBOLEDA



9 789505 150192

Escuela de Filosofía y Humanidades
Escuela de Ciencias Exactas e Ingenierías
Escuela de Educación

UNIVERSIDAD SERGIO ARBOLEDA

Carrera 15 No. 74-40. Tels.: (571) 3257500 ext. 2131 - 3220538. Bogotá, D.C.

Calle 18 No. 14A-18. Tels.: (575) 4203838 - 4202651. Santa Marta.

Calle 58 No. 68-91. Tel.: (575) 3689417. Barranquilla

www.usergioarboleda.edu.co

IMPORTANCE OF ICT IN THE TEACHING-LEARNING PROCESS: MIDDLE AND HIGHER EDUCATION STUDIES

Compilers

Irma Amalia Molina Bernal
Juan Carlos Morales Piñero
Sergio Alejandro Rodríguez Jerez



UNIVERSIDAD
SERGIO ARBOLEDA

IMPORTANCE OF ICT IN THE TEACHING-LEARNING PROCESS: MIDDLE AND HIGHER EDUCATION STUDIES

Compilers

Irma Amalia Molina Bernal
Juan Carlos Morales Piñero
Sergio Alejandro Rodríguez Jerez

Authors

Sergio Alejandro Rodríguez Jerez
Juan Carlos Morales Piñero
María Carolina Cote Sánchez
Irma Amalia Molina Bernal
Brayan Molina Martínez
Henry Martínez León
Gloria Tarrío Villaverde
Claudia Salazar Alonzo
Esequiel Rojas Torres



UNIVERSIDAD
SERGIO ARBOLEDA

Importance of ICT in the teaching-learning process: middle and higher education studies / compilers Irma Amalia Molina Bernal, Juan Carlos Morales Piñero, Sergio Alejandro Rodríguez Jerez ; authors Sergio Alejandro Rodríguez Jerez ... [et al.] – Bogotá: Universidad Sergio Arboleda, 2020.

215 p.

ISBN: 978-958-5158-09-2

1. Education - Technological innovations 2. Educational technology 3. Educational technology - Moral and ethical aspects 4. Educational innovations 5. Learning - Technological innovations 6. Educational tests and measurements - Technological innovations I. Molina Bernal, Irma Amalia, ed. II. Morales Piñero, Juan Carlos, ed. III. Rodríguez Jerez, Sergio Alejandro, ed. IV. Title

371.334 ed. 22

IMPORTANCE OF ICT IN THE TEACHING-LEARNING PROCESS: MIDDLE AND HIGHER EDUCATION STUDIES

ISBN: 978-958-5158-09-2 (.pdf)

Doi: 10.22518/book/9789585158092

© **Universidad Sergio Arboleda**

Escuela de Filosofía y Humanidades
Escuela de Ciencias Exactas e Ingenierías
Escuela de Educación

Compilers

Irma Amalia Molina Bernal
Juan Carlos Morales Piñero
Sergio Alejandro Rodríguez Jerez

Authors

Sergio Alejandro Rodríguez Jerez
Juan Carlos Morales Piñero
María Carolina Cote Sánchez
Irma Amalia Molina Bernal
Brayan Molina Martínez
Henry Martínez León
Gloria Tarrío Villaverde
Claudia Salazar Alonzo
Esequiel Rojas Torres

This book was supported by the Instituto Colombiano para la Evaluación de la Educación - ICFES under public call.

This book had a peer review process.

First published: december 2020

Fondo de Publicaciones de la
Universidad Sergio Arboleda.

The contents of the book does not represent the opinion of the Univaersidad Sergio Arboleda. The authors assume responsibility for the opinions expressed.

Included in the Book Citation Index
(Social Sciences & Humanities)

Editorial Staff

Diana Niño Muñoz
Deisy Janeth Osorio Gómez
Dirección de Publicaciones Científicas

Traslation:

Pass Traslation Service

Design and layout:

Maruja Esther Flórez Jiménez

Cover image: Dreamstime.com

Fondo de Publicaciones
Universidad Sergio Arboleda

Calle 74 No. 14-14.
Teléfono: (571) 325 7500 ext. 2131/2260.
Bogotá, D.C.

www.usergioarboleda.edu.co

Printed:

DGP Editores, Bogotá, D.C.



Attribution-NonCommercial-NoDerivatives 4.0 International
(CC BY-NC-ND 4.0).

Index

Introduction.....	9
Chapter 1	
The TPACK model as an analysis perspective	
in the integration of ICTs in education: a state of the art.....	13
Introduction	14
Methodology	17
Results	18
Conclusions	25
References	26
Chapter 2	
ICTs and their impact on academic results: an analysis	
based on the TPACK model.....	33
Introduction	34
Methodology	39
Analysis unit and population	39
Data collection.	40
Techniques and variables.....	41
Lineal regression.	41
ANOVA.....	44
Results	44
Linear regression and ANOVA.....	44
Discussion	59
References	60
Annex 1. Questionnaire used to collect the information.....	63
Chapter 3	
Evaluating the Efficiency of schools in Bogotá and	
Cundinamarca: a metafrontier analysis.....	71
Introduction	72
Methodology	73

Population and sample	75
Variables	76
Metafrontier of the study	78
Results	80
Conclusions	89
References	90

Chapter 4

ICTs and their impact on secondary education schools: Case studies

in Bogotá and Cundinamarca.....	93
Introduction	94
State of the art.....	95
National context	96
International context	99
Methodology.....	105
Information gathering management.....	106
Analysis and results	107
Discussion	128
References	129

Chapter 5

Educational software and its impact on the learning process in university

Problem statement and justification	134
State of the art.....	136
Methodology.....	140
Study contribution.....	145
References	149
Annexes.....	152
Program for Propositional Logic activities.....	152
Sessions for the application of the LógicaUCAB Software	153
Evaluation activities	157

Chapter 6

Integration of ICTs in reading and writing teaching and learning

in college	161
ICTs integration in reading and writing teaching-learning in the	
University: state of the art	164
ICTs in the University.....	164
ICTs in reading and writing teaching and learning at the University	165
Conclusions	169
Defining the guidelines.....	169

Teacher training	169
Focusing teaching on real situations.....	170
Establishing the “draft policy”	170
Defining explicit assessment criteria	170
Develop writing tutoring programs.....	171
Work on the dissemination of tools to prevent or confront procrastination.....	172
Benefits and risk ICT integration in reading and writing teaching-learning in the University.....	172
References	173
Chapter 7	
Ethics in educational technology: a perspective in the light of philosophical texts on technique	177
Introduction	178
The challenge of the technique.....	180
Hermeneutics in qualitative research	183
Technique in interpreted texts.....	186
Ethical postulates	202
Final discussion	213
References	214

The TPACK model as an analysis perspective in the integration of ICTs in education: a state of the art

Sergio Alejandro Rodríguez Jerez¹

Abstract

The process of integrating ICTs in education is a phenomenon that has been relatively studied in recent decades. Nevertheless, throughout the last five years, due to the dynamics of what is now called the digital age, the concern to improve education using new technologies has increased. This chapter aims to analyze the most relevant publications on this matter to describe the status quo. The TPACK model is used as an analysis perspective due to its high relevance in integrating ICTs in education. Likewise, the descriptive methodology uses the interpretation levels proposed by Rodríguez Jerez (2019) to carry out a hermeneutic analysis. The results obtained are organized from the area, and the units of convergence are found. The conclusions provide a framework to reflect and understand the current process of integrating ICTs in teaching and learning.

Keywords

ICTs, education, TPACK model

¹ Ph.D. in Knowledge Society and Action in the Fields of Education, Communication, Rights and New Technologies of the International University of La Rioja. Ph.D. candidate at the Autonomous University of Barcelona. Master's in education from the University of La Salle. Expert in Analytics of the Knowledge Society at the International University of La Rioja. Psychologist of the Pilot University of Colombia. Academic Director of the Dean's Office of Innovation and Digital Development and Director of Research of the School of Philosophy and Humanities of the Sergio Arboleda University. E-mail: sergio.rodriguez@usa.edu.co

Introduction

In 1937, Ortega & Gasset (1982) outlined, for one of the first times, the need to study technique as a co-substantial element of humanity: technique emerges from the need to take over the environment and transform matter, through methods, procedures, and tools for the benefit of man. For both Ortega and Heidegger (1997), humankind becomes more human due to technique. The possibility of transforming the environment is prevalent in the construction of societies. However, every action that comes from man is full of intention.

The industrial revolution highlighted the supremacy of technique, which world wars later ratified. Technology thus arises as a field of an in-depth study of technique and humanity surrenders, almost wholly, to a race in favor of appropriating the most efficient methods to solve the problems that surround us, which is why the fourth industrial revolution assumed technology as the designating element of new societies (Vinck, 2018). Now, life cannot be contemplated without technology. As UNESCO's director, Irina Bokova, points out: this is not a digital revolution, but a digital civilization (Vinck, 2018, p. 13). Consequently, on the one hand, we have technology as a reference for human development and, on the other, the use of technology-based on the intention of each subject. Technique and use are the aspects to consider no longer in the meditation of technique but the meditation of technology. In other words, the thoughts of Ortega and Heidegger must now delve into a new and broader spectrum than the one envisioned in the twentieth century.

The current technological development is overwhelming. The transition from the first to the second industrial revolution lasted more than 100 years, while it only lasted 20 from the third to the fourth. The speed of technological development is exponential, so some people infer that the fifth revolution is about to happen (Maxwell, 2014).

Considering this, ICTs have become a benchmark for study in multiple fields, and education is no exception. Since 1991, for example, the need to incorporate ICTs in education has been a preponderant concern for the Colombian State. With Law 115 of 1994 and with the appearance of the

General Systems of Accreditation of Education² in Colombia, the need to immediately improve the educational quality indexes of the country is recognized.

In this sense, and thanks to the technological and communicative development of recent times, the Ministry of National Education (MEN³) has designed a series of ICT integration policies in education systems. The Live Digital Plan⁴ 2014-2018 demonstrates the above and reveals the urgency of using ICTs as tools for the improvement of education.

However, this current urgency of incorporating ICTs in classrooms requires meditation, a moment of reflection in which the scope, limitations, and phenomena of both complimentary and malicious use of technology are put on the scale. Also, meditation or reflection involves an analysis perspective. For example, Mishra & Koehler (2006) explained the TPACK model to analyze the process of integrating ICTs within the framework of pedagogical practice. The TPACK model does not correspond to a created model, but to the study of the factors that are always present in integrating ICTs in education. Therefore, this model serves as the analysis perspective to study any training process from the world of teacher knowledge.

The TPACK refers to the knowledge that a teacher has on coordinating the use of specific activities of the subjects or activities on specific topics, doing so with representations on certain topics, using ICTs to facilitate student learning. As the technologies used in these activities and representations become ubiquitous, the TPACK becomes PCK. In short, it refers to the didactic knowledge of the content to the knowledge required by teachers to integrate technology in their teaching in any content area (Cabero, Marín, & Castaño, 2015).

The TPACK model then becomes the immediate reference to analyze the integration of ICTs in teaching processes. The TPACK model has been used as an analytical perspective for improving pedagogical processes in all academic fields, from essential to university education, as suggested by

² Sistemas Generales de Acreditación de la Educación

³ Ministerio de Educación Nacional

⁴ Plan Vive Digital

the consulted bibliography. The use and impact of the referred model first spread in the United States. Mishra & Koehler (2006) were responsible for popularizing it and making it accessible to different pedagogical spheres not only in North America, but also in Europe, Asia, and Australia, as it began to be part of proposals by authors such as Jimoyiannis (2010) in Greece, Jamieson-Proctor, Finger & Albion (2010) in Australia, and Jang & Tsai (2012) in China.

It seems that the inclusion of the TPACK model in the different academic scenarios around the world and the extraordinary results it has shown in the face of the evolution of pedagogy and the new ways of teaching that technology offers has a direct impact on what and how the students of this century learn. Thus, it can be assumed that the use of technological tools allows the knowledge imparted in the classroom to be more quickly and efficiently assimilated. However, it would be worth corroborating the above with a study that documented and analyzed the high-impact researches from the last five years that have tried to evaluate, using the TPACK model as a reference framework, the process of ICT integration in the world. It can be therefore deduced that the question to be answered is: What has been the status quo, during the last five years, of scientific publications regarding the integration of ICTs in education through the TPACK model as an analysis perspective?

The following general objective must be fulfilled:

Describe the current situation of high-impact scientific publications that refer to the process of integrating ICTs in education, based on the reference framework of the TPACK model.

Similarly, to achieve the general objective, the following specific objectives are established:

Document the scientific research related to the integration of ICTs in education in the last five years.

Discriminate, using a scientometric analysis, the most relevant publications from the last five years regarding integrating ICTs in education using the TPACK model.

Analyze high-impact scientific production of the last five years about integrating ICTs in education using the TPACK model, through a chronological and geographical study.

Methodology

The present study is a descriptive analysis of the high-impact scientific publications from the last five years that have studied the integration of ICTs in education, based on the referential framework proposed by the TPACK model. The research was divided into five phases:

The first phase consisted of carrying out an integrated search of all the publications referring to the proposed topic, taking as a primary unit of analysis of the last five years' chronological delimitation. The academic database integration tool offered by EBSCO was used with the following search criteria equation:

Filter 1: $\forall(U: publications \rightarrow (ICT \cup TIC \cup Information_{Tech}))$

Filter 2: $\forall(Filter1: publications \rightarrow (education \cap Tpack))$

Filter 3: $\forall(filter\ 2: publications \rightarrow (year2015 \cap year\ 2016 \cap year\ 2017 \cap year\ 2017 \cap year\ 2018 \cap year\ 2019))$

Filter 4: $\forall(filter\ 3\ publications \rightarrow education)$

After this first gathering of information, the researches that expressly referred to the process of ICT integration using the TPACK model were outlined with a standard state of the art matrix in which, based on the data offered by each of the publications recovered in the first phase, those that used the TPACK model as an analysis perspective of qualification were qualitatively refined.

In the third phase, the 704 profiled publications with the established criteria underwent a scientometric impact factor analysis to determine how many of them could be classified as high impact. The following criteria established this indicator:

- a. Number of indexed citations
- b. Resource usage percentage (full resource views, resource summary view resource hyperlink number, resource link in social networks)

- c Resource capture percentage (number of downloads, number of readers)

The scientometrics used was mediated by Plum Analytics metrics, which allowed for greater fidelity of the high-impact criteria.

In the fourth phase, a hermeneutical analysis of speech saturation and contrast was carried out to cross-examine the information obtained descriptively. A fundamental statistic was made from the purification carried out in the previous phase, which allowed to delimit the number of articles, used as an analysis corpus, to 53 in total. Taking as reference the year and the area of publication, the respective crossing of information was made to determine the convergences and divergences found in the information contained in each of the publications. The methodology followed in this hermeneutic saturation and contrast analysis corresponds to the proposal of Rodríguez Jerez (2019), precisely the technique presented by the author to determine the interpretative levels of a text.

In the last phase, the information was compiled, and the results were presented.

Results

According to the established search criteria, of the 704 publications found from the last five years, only 53 are of high impact and its descriptive analysis are showed in tables 1.1 and 1.2.

Tabla 1.1
Total description of high-impact publications by area

DESCRIPTION BY AREA	COUNT
EUROPE	28
ASIA	10
NORTH AMERICA - CANADA	8
OCEANIA	4
AFRICA	2
LATIN AMERICA	1
Total	53

Nota: most of the high-impact publications are concentrated in Europe, especially in the Nordic area of the continent.

Table 1.2
Total description of high-impact publications in the European area

Row tags	Count Europe
GERMANY	1
BELGIUM	1
SPAIN	9
ESTONIA	1
FINLAND	2
HOLLAND	4
LITHUANIA	1
NORWAY	6
UNITED KINGDOM	1
SWEDEN	1
SWITZERLAND	1
Total	28

Note: countries such as Norway, Finland, Estonia, Lithuania are represented in the given sample.

This poses a series of qualitative reflections from the hermeneutical analysis of these corpora in particular. In Norway, for example, the researchers found focus on three dimensions: a. ICT impact on academic performance; b. ICT impact on the improvement of teaching practice; C. TPACK model as an analysis tool to measure the integration of ICTs in education.

It is necessary to emphasize that, in quantitative studies such as Scherer, Rohatgi & Hatlevik's (2017), the results evidence that the integration of ICTs does not significantly affect academic performance. Nevertheless, as a positive effect, the study by Scherer, Tondeur, Siddiq & Baran (2018) points out that the integration of ICTs, using the TPACK model as a reference for the analysis, improves the attitude of both the teacher and the student regarding the new demands of digital civilization.

The second dimension refers to the impact of ICTs in pedagogical practice. Quantitative studies, such as Tømte, Enochsson, Buskqvist &

Kårstein (2015), have similar results: It cannot be demonstrated that ICTs improve the teaching process directly. However, qualitative studies such as Xiang Ying Mei, Endre Aas, & Magnhild Medgard (2019) point out otherwise. In this case, the contradiction is engaging. The first possible hypothesis is that there seems to be a social imaginary around the advantages of ICTs in education. This imaginary, whether due to the lack of an objective measurement model, has not been proven in a real scenario or, on the contrary, shows that this vision draws away from how ICTs affect educational environments. As a result of a study of interpretative convergences, it can be noticed that high-impact researches from Germany, Finland, Lithuania, Sweden, Switzerland, and Estonia has the following elements in common: a. improvement of pedagogical practice through ICTs; b. TPACK model as an analysis tool to evaluate the integration of ICTs in the classroom; c. student perception of ICT-mediated education; d. ICTs as elements that allow human development.

Concerning the first element referred to, the studies by Spante, Karlssen, Nortvig, & Christiansen (2014) and Taimalu & Luik (2019) indicate that the impact of ICTs on teaching processes is positive but in the domain of technological knowledge. According to the TPACK model, the technological domain is only one of the references in integrating ICTs in education. Thus, it can be inferred that the practice does not improve, although it does provide conditions and possibilities to be more effective. Similarly, apropos of the second element, the studies by Valtonen et al. (2017) and Lachner, Backfisch & Stürmer (2019), argue that it is necessary to create more reliable measuring instruments to determine the integration of technologies through the TPACK model. This implies thinking that there may be a bias, to some extent, from a quantitative point of view in determining the incidence of ICTs in teaching processes.

Regarding the third element, Sointu et al. (2019) conduct a study with more than 317 students from Finland and conclude that incorporating the TPACK model in secondary education helps improve the favorable perception of students of their teachers. This finding is especially interesting since technology can be seen as an element of willingness to learn more than to improve learning. Finally, it is suggestive how in the Nordic countries, in addition to the concern of analyzing the integration of ICTs in education

as a necessary element to improve educational quality, there is a concern for applying ICTs as an articulating axis of national development, as can be seen in the studies carried out by Yildiz (2016) and Petko, Egger, Cantieni & Wespi (2015).

After reviewing the Nordic area, the same process of convergence and divergence analysis was carried out in Belgium, Spain, Holland, and the United Kingdom. Consequently, the following convergent elements were found: a. the TPACK model to analyze the process of integration of ICTs in education; b. ICTs as an indicator of impact on the improvement of pedagogical practices; c. integrating ICTs in teaching practice.

Faced with the first convergence, the studies by Bueno-Alastuey, Villarreal & García Esteban (2018) and Cubeles & Riu (2018) refer to the effectiveness of the TPACK model to determine, on the one hand, how the digital competence of higher education teachers can be evaluated with this analysis perspective and, on the other hand, how this same framework can be used to analyze specific elements of the digital practices of teaching such as telecollaboration. The studies above are quantitative. The samples used are case studies, so it cannot be inferred that they are representative referents of a specific population.

Concerning the second element, the research carried out by Almerich, Orellana, Suárez-Rodríguez & Díaz-García (2016) reveals how digital competencies positively affect pedagogical competencies with a sample of 1,095 primary schools, secondary and higher-level teachers of the Valencian community in Spain. It was proved that the management of ICTs improves teaching competencies in the different levels of training.

The third element of this unit of analysis refers to the process of ICTs integration with teaching mechanisms. The studies developed by Kosnik et al. (2016), Tondeur, Scherer, Siddiq & Baran (2017), Haydn (2014), Gutiérrez Porlán (2014), Moreira-Fontán, García-Señorán, Conde-Rodríguez & González, (2019), Sánchez-Prieto, Hernández-García, García-Peñalvo, Chaparro-Peláez & Olmos-Migueláñez (2019), Uerz, Volman & Kral (2018) present various explanatory models for this integration, depending on the specific context of each one. However, it is interesting to find that

the integration process is tricky in technological knowledge and more than ICT infrastructure that is not effective and efficient for specific teaching demands. Consequently, the term digital self-efficacy becomes a necessary element in appropriating ICTs for teaching with quality standards. The study carried out by Tondeur, Aesaert, Prestridge & Consuegra (2018) in Belgium stands out: through an empirical study, the authors demonstrated how gender and age variables are not relevant in the processes of ICT integration in education.

After analyzing the European area, the Asian area's high-impact publications will be reviewed in table 1.3.

Table 1.3
Total description of high-impact publications in the Asian area

COUNTRY	AREA Count
CHINA	5
SOUTH KOREA	1
TAIWAN	3
TURKEY	1
Total	10

Note: high-impact publications are in China.

In the hermeneutical analysis carried out in this country's publications, the following convergent elements are identified: a. ICTs as an aspect that improves teaching practice; b. ICTs as an aspect that improves the quality of education.

The studies of Wu, Hu, Gu & Lim (2016), Xiong & Lim (2015), and Mei (2019) expose the advantages of digital awareness over teacher performance. For example, Xiong & Lim (2015) carried out a research that took into account two teacher training programs in higher education and showed, using a sample of 99 people, to understand the need to integrate ICTs in teaching practice is related to curriculum leadership. In other words, the research indicated that several people who have a leading role in the processes of systematization of education are aware of the new challenges demanded by the digital era. On the other hand, and about the second

element mentioned above, ICTs in China's high-impact research that uses the TPACK model as an analysis perspective has no impact on student performance. The quantitative studies carried out by Wang, Tigelaar & Admiraal (2019) and Li, Sun & Jee (2019) show that, as demonstrated by Li, Sun & Lee (2019), they affect, for example, the quality of the learning acquired by the students in the particular case of a second language.

The convergent elements identified in South Korea, Taiwan, and Turkey are a. TPACK as a benchmark for analysis in the ICT integration process; b. the impact of ICTs in improving teaching practice. For Akyuz (2018), Chuang, Weng & Huang (2015), and Tseng, Cheng & Yeh (2019), the TPACK model must be redefined from the context in which it is used. According to its quantitative research results, the reference model does not cover the entire framework of integration possibilities. Secondly, Hsu (2017) and Joo, Lim & Kim (2016) ratify what has been found in other areas: ICTs do not directly affect the improvement of teaching practice, but they help to be more aware of the importance of technology. In other words, ICTs allow improving the attitudinal component of teachers considering the demands of the present time.

After analyzing the Asian area, the area between North America and Canada will be reviewed in table 1.4.

Table 1.4.
Total description of high-impact publications
in the North American area

NORTH AMERICA - CANADA	Count
CANADA	2
UNITED STATES	6
Total	8

The North American area investigations converge in the following elements: a. the TPACK model as an instrument of analysis in the integration of ICTs in education; b. ICT impact on teaching practice; C. ICT integration models in education. About the first element, the author's Stockless, Villeneuve & Gingras (2018), Lefebvre Sonia (2014),

and Nelson, Voithofer & Cheng (2019) state that the TPACK model allows the understanding of the integration of ICTs in the classroom from the didactic point of view. However, Cheng & Xie (2018) point out in a quantitative study carried out with a sample of 109 professors from the United States that the TPACK model only effectively measures the belief system.

Regarding the impact of ICTs on teaching, the studies by McCulloch, Hollebrands, Lee, Harrison & Mutlu (2018) and Blackwell, Lauricella & Wartella (2016) conclude that ICTs, by themselves, do not have an impact on the improvement of teaching practices. The integration of ICTs improves the attitudinal and motivational components; some of the values are required to develop a quality training experience. For this reason, the researchers mentioned above emphasize the importance of advancing in the understanding of the development of digital competence in teachers.

In the case of Oceania, the only country that has produced high-impact research in Australia. Of the four investigations found, two of them present a state of the art to analyze the integration of ICTs in education (Lai & Bower, 2019; Pretto & Curró, 2017). The other two show how the TPACK model offers excellent advantages to analyze the integration of ICTs in teaching and learning processes (Gill & Dalgarno, 2017; Reyes, Reading, Doyle & Gregory, 2017).

In Africa, two high-impact research types were found: one in Tanzania and one in the Cape Peninsula (Chigona, 2015; Kihoza, Zlotnikova, Bada & Kalegele, 2016). Both cases demonstrated how the TPACK model was a useful reference for analyzing the process of integrating ICTs in education. It is striking that the study presented by Kihoza et al. (2016) combines the TPACK with the SAMR model: the research suggests that the integration of an explanatory model such as the TPACK with a methodological model such as the SAMR offers a much better glimpse of the integration process mentioned above.

In Latin America, the only high-impact material found was Agustín Flores' (2018). In this research, the TPACK model was used to explain the National University of the Northeast's technological pedagogical content

knowledge in Argentina. It shows that, in this particular case, the TPACK model is a useful tool for evaluating and explaining the process of integrating ICTs in education.

Conclusions

The synthesis of the results obtained allows deducing that the TPACK model will not reveal ICT integration's complexity in the teaching and learning processes. Any study that attempts to analyze the referred integration process must use another additional mechanism, qualitative methodologies, more profound descriptive methods, or complex data analysis methods to comprise this complex phenomenon.

It is also interesting to perceive how ICTs begin to become a part of human development plans' daily discourse. This leads us to think that there can be several imaginaries regarding the advantages offered by ICTs in different areas. For this reason, fundamentally, it is necessary to meditate and reflect on technology, and that way, clear the air from propaganda and the immediacy of the world.

However, it is almost definitive that the TPACK model does allow analyzing the belief system and the level of awareness of teachers about the need to integrate ICTs in teaching processes. Nevertheless, it is pertinent to clarify that the TPACK model is a theoretical and non-operational "framework." The proposal by Kihoza et al. (2016) to integrate an operating model as SAMR is thus of interest. This model incorporates metacognitive procedures to create the ability to handle teaching technologies (Jude, Kajura & Birevu, 2014; López-García, 2015; Tsybulsky & Levin, 2016).

If knowledge and technology management is considered a skill of 21st-century teachers, there must be a theoretical and operational reference framework for teachers' 21st-century digital skills. As set out in the various training frameworks, competencies must integrate the attitudinal, epistemological, praxeological, and ethical components that teaching entails, considering the new digital civilization (Almerich et al., 2016; Punie, 2007; Sampson & Fytros, 2008). Perhaps this is the course that must be followed to improve the training spaces in the world.

Finally, the concept of digital self-efficacy is an essential reference to continue researching and carrying out actions in pedagogical and didactic environments. Teaching quality is becoming more complicated due to the saturation of persistent information in the knowledge society. The objective is to create paths to understand society's problems and establish improvement strategies with the advantages offered by the 4.0 world.

For future research with the same main objective as this study, it is recommended to have a more significant sample that considers the impact factor and the established period. It is very likely that, due to the current scientific publication and dissemination processes, the investigations that are working on the subject referred to have not been visualized in the tools used. Likewise, it is advised that the analysis of the literature use defined interpretation techniques to reduce, to some extent, the natural biases that occur when the information is analyzed qualitatively.

References

- Akyuz, D. (2018). Measuring technological pedagogical content knowledge (TPACK) through performance assessment. *Computers and Education*, 125, 212–225. doi: 10.1016/j.compedu.2018.06.012
- Almerich, G., Orellana, N., Suárez-Rodríguez, J., & Díaz-García, I. (2016). Teachers' information and communication technology competences: A structural approach. *Computers and Education*, 100, 110–125. doi: 10.1016/j.compedu.2016.05.002
- Blackwell, C. K., Lauricella, A. R., & Wartella, E. (2016). The influence of TPACK contextual factors on early childhood educators' tablet computer use. *Computers and Education*, 98, 57–69. doi: 10.1016/j.compedu.2016.02.010
- Bueno-Alastuey, M. C., Villarreal, I., & García-Esteban, S. (2018). Can telecollaboration contribute to the TPACK development of pre-service teachers? *Technology, Pedagogy and Education*, 27(3), 367–380. doi: 10.1080/1475939X.2018.1471000
- Cabero, J., Marín, V., & Castaño, C. (2015). Validation of the application of TPACK framework to train teacher in the use of ICT. *@tic. Revista d'innovació Educativa*, 0(14), 13–22. doi: 10.7203/attic.14.4001

- Cheng, S. L., & Xie, K. (2018). The relations among teacher value beliefs, personal characteristics, and TPACK in intervention and non-intervention settings. *Teaching and Teacher Education*, 74, 98–113. doi: 10.1016/j.tate.2018.04.014
- Chigona, A. (2015). Pedagogical shift in the twenty-first century: preparing teachers to teach with new technologies. *Africa Education Review*, 12(3), 478–492. doi: 10.1080/18146627.2015.1110912
- Chuang, H.-H., Weng, C.-Y., & Huang, F.-C. (2015). A structure equation model among factors of teachers' technology integration practice and their TPACK. *Computers & Education*, 86, 182–191. doi: 10.1016/j.compedu.2015.03.016
- Cubeles, A., & Riu, D. (2018). The effective integration of ICTs in universities: the role of knowledge and academic experience of professors. *Technology, Pedagogy and Education*, 27(3), 339–349. doi: 10.1080/1475939X.2018.1457978
- Flores, A. (2018). Didactic conceptions and use of ICT in the university education of degree. Multi-case study and TPACK analysis framework. *Praxis Educativa*, 22(1), 64–72. doi: 10.19137/praxiseducativa-2018-220106
- Gill, L., & Dalgarno, B. (2017). A qualitative analysis of pre-service primary school teachers' TPACK development over the four years of their teacher preparation programme. *Technology, Pedagogy and Education*, 26(4), 439–456. doi: 10.1080/1475939X.2017.1287124
- Gutiérrez, I. (2014). Perfil del profesor universitario español en torno a las competencias en tecnologías de la información y la comunicación. *Pixel-Bit Revista de Medios y Educación*, 51–65. doi: 10.12795/pixelbit.2014.i44.04
- Haydn, T. (2014). How do you get pre-service teachers to become 'good at ICT' in their subject teaching? The views of expert practitioners. *Technology, Pedagogy and Education*, 23(4), 455–469. doi: 10.1080/1475939X.2014.892898
- Heidegger, M. (1997). La pregunta por la técnica. In *Filosofía, Ciencia y Técnica*.
- Hsu, S. (2017). Developing and validating a scale for measuring changes in teachers' ICT integration proficiency over time. *Computers and Education*, 111, 18–30. doi: 10.1016/j.compedu.2017.04.001
- Jamieson-Proctor, R., Finger, G., & Albion, P. R. (2010). Auditing the TPACK Capabilities of Final Year Teacher Education Students: Are they ready for

- the 21st century? In *Digital Diversity: Australian Computers in Education Conference 2010*.
- Jang, S. J., & Tsai, M. F. (2012). Exploring the TPACK of Taiwanese elementary mathematics and science teachers with respect to use of interactive whiteboards. *Computers and Education*. doi: 10.1016/j.compedu.2012.02.003
- Jimoyiannis, A. (2010). Designing and implementing an integrated technological pedagogical science knowledge framework for science teachers professional development. *Computers and Education*. doi: 10.1016/j.compedu.2010.05.022
- Joo, Y. J., Lim, K. Y., & Kim, N. H. (2016). The effects of secondary teachers' technostress on the intention to use technology in South Korea. *Computers and Education*, 95, 114–122. doi: 10.1016/j.compedu.2015.12.004
- Jude, L., Kajura, M., & Birevu, M. (2014). Adoption of the SAMR Model to Assess ICT Pedagogical Adoption: A Case of Makerere University. *International Journal of E-Education, e-Business, e-Management and e-Learning*, 4(2). doi: 10.7763/ijeeee.2014.v4.312
- Kihoza, P., Zlotnikova, I., Bada, J., & Kalegele, K. (2016). Classroom ICT integration in Tanzania: Opportunities and challenges from the perspectives of TPACK and SAMR models. *International Journal of Education and Development Using Information and Communication Technology*, 12(1), 107–128.
- Kosnik, C., White, S., Beck, C., Marshall, B., Lin Goodwin, A., & Murray, J. (2016). *Building bridges: Rethinking Literacy Teacher Education in a Digital Era*. doi: 10.1163/9789463004916
- Lachner, A., Backfisch, I., & Stürmer, K. (2019). A test-based approach of Modeling and Measuring Technological Pedagogical Knowledge. *Computers & Education*, 142, 103645. doi: 10.1016/j.compedu.2019.103645
- Lai, J. W. M., & Bower, M. (2019). How is the use of technology in education evaluated? A systematic review. *Computers and Education*, 133, 27–42. doi: 10.1016/j.compedu.2019.01.010
- Lefebvre Sonia, P. D. (2014). Intégration des technologies de l'information et de la communication: types de connaissances abordées dans le discours d'enseignants en exercice et d'étudiants en formation initiale. *Canadian Journal of Education / Revue Canadienne de l'éducation*, 37(3),

1. Retrieved September 26, 2019 from <http://pdfs.semanticscholar.org/1105/21303871ff44627a121d8e2715a6468d409b.pdf>
- Li, G., Sun, Z., & Jee, Y. (2019). The more technology the better? A comparison of teacher-student interaction in high and low technology use elementary EFL classrooms in China. *System*, 84, 24–40. doi: 10.1016/j.system.2019.05.003
- López-García, J.-C. (2015). SAMR, modelo para integrar las TIC en procesos educativos. Retrieved from: <http://Eduteka.Icesi.Edu.Co/Articulos/Samr> website: <http://eduteka.icesi.edu.co/articulos/samr>
- Maxwell, I. A. (2014). The fifth industrial revolution. *Chemistry in Australia*, p. 38.
- McCulloch, A. W., Hollebrands, K., Lee, H., Harrison, T., & Mutlu, A. (2018). Factors that influence secondary mathematics teachers' integration of technology in mathematics lessons. *Computers and Education*, 123, 26–40. doi: 10.1016/j.compedu.2018.04.008
- Mei, B. (2019). Preparing preservice EFL teachers for CALL normalisation: A technology acceptance perspective. *System*, 83, 13–24. doi: 10.1016/j.system.2019.02.011
- Mei, X. Y., Aas, E., & Medgard, M. (2019). Teachers' use of digital learning tool for teaching in higher education: Exploring teaching practice and sharing culture. *Journal of Applied Research in Higher Education*, 11(3), 522–537. doi: 10.1108/JARHE-10-2018-0202
- Mishra, P., & Koehler, M. J. (2006a). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*. doi: 10.1111/j.1467-9620.2006.00684.x
- Moreira-Fontán, E., García-Señorán, M., Conde-Rodríguez, Á., & González, A. (2019). Teachers' ICT-related self-efficacy, job resources, and positive emotions: Their structural relations with autonomous motivation and work engagement. *Computers and Education*, 134, 63–77. doi: 10.1016/j.compedu.2019.02.007
- Nelson, M. J., Voithofer, R., & Cheng, S. L. (2019). Mediating factors that influence the technology integration practices of teacher educators. *Computers and Education*, 128, 330–344. doi: 10.1016/j.compedu.2018.09.023

- Ortega & Gasset, J. (1982). Meditación de la técnica y otros ensayos sobre ciencia y filosofía. In *Obras de José Ortega & Gasset*. Madrid, España: Revista de Occidente/ Alianza Editorial.
- Petko, D., Egger, N., Cantieni, A., & Wespi, B. (2015). Digital media adoption in schools: Bottom-up, top-down, complementary or optional? *Computers and Education*, 84, 49–61. doi: 10.1016/j.compedu.2014.12.019
- Pretto, G., & Curró, G. (2017). An Approach for Doctoral Students Conducting Context-Specific Review of Literature in IT, ICT, and Educational Technology. *New Review of Academic Librarianship*, 23(1), 60–83. doi: 10.1080/13614533.2016.1227861
- Punie, Y. (2007). Learning spaces: An ICT-enabled model of future learning in the Knowledge-based Society. *European Journal of Education*, 42(2), 185–199. doi: 10.1111/j.1465-3435.2007.00302.x
- Reyes, V. C., Reading, C., Doyle, H., & Gregory, S. (2017). Integrating ICT into teacher education programs from a TPACK perspective: Exploring perceptions of university lecturers. *Computers and Education*, 115, 1–19. doi: 10.1016/j.compedu.2017.07.009
- Rodríguez Jerez, S. A. (2019). Aproximaciones de una metodología semiótica para el análisis de la educación en Colombia: un aporte al desarrollo de la edusemiótica. *PRACS: Revista Eletrônica de Humanidades Do Curso de Ciências Sociais Da UNIFAP*, 11(2), 117. doi: 10.18468/pracs.2018v11n2.p117-126
- Sampson, D., & Fytros, D. (2008). Competence Models in Technology-Enhanced Competence-Based Learning. In *Handbook on Information Technologies for Education and Training* (pp. 155–177). doi: 10.1007/978-3-540-74155-8_9
- Sánchez-Prieto, J. C., Hernández-García, Á., García-Peñalvo, F. J., Chaparro-Peláez, J., & Olmos-Migueláñez, S. (2019). Break the walls! Second-Order barriers and the acceptance of mLearning by first-year pre-service teachers. *Computers in Human Behavior*, 95, 158–167. doi: 10.1016/j.chb.2019.01.019
- Scherer, R., Rohatgi, A., & Hatlevik, O. E. (2017). Students' profiles of ICT use: Identification, determinants, and relations to achievement in a computer and information literacy test. *Computers in Human Behavior*, 70, 486–499. doi: 10.1016/j.chb.2017.01.034
- Scherer, R., Tondeur, J., & Siddiq, F. (2017). On the quest for validity: Testing the factor structure and measurement invariance of the technology-dimensions in

- the Technological, Pedagogical, and Content Knowledge (TPACK) model. *Computers and Education*, 112, 1–17. doi: 10.1016/j.compedu.2017.04.012
- Scherer, R., Tondeur, J., Siddiq, F., & Baran, E. (2018). The importance of attitudes toward technology for pre-service teachers' technological, pedagogical, and content knowledge: Comparing structural equation modeling approaches. *Computers in Human Behavior*, 80, 67–80. doi: 10.1016/j.chb.2017.11.003
- Sointu, E., Valtonen, T., Hirsto, L., Kankaanpää, Jenni Saarelainen, M., Makitalo, K., Smits, A., & Manninen, J. (2019). Teachers as users of ICT from the student perspective in higher education flipped classroom classes. *Seminar.Net: Media, Technology & Lifelong Learning*, 15(1), 1–15.
- Spante, M., Karlsen, A. V., Nortvig, A.-M., & Christiansen, R. B. (2014). Cross-Border Collaboration in History among Nordic Students: A Case Study about Creating Innovative ICT Didactic Models. In *IAFOR Journal of Education* (Vol. 2). doi: 10.22492/ije.2.2.02
- Stockless, A., Villeneuve, S., & Gingras, B. (2018). Maitrise d'outils technologiques : son influence sur la compétence TIC des enseignants et les usages pédagogiques | Mastery of Digital Tools: The Influence on Information and Communication Technologies Competency and Pedagogical Use. *Canadian Journal of Learning and Technology*, 44(2). doi: 10.21432/cjlt27581
- Taimalu, M., & Luik, P. (2019). The impact of beliefs and knowledge on the integration of technology among teacher educators: A path analysis. *Teaching and Teacher Education*, 79, 101–110. doi: 10.1016/j.tate.2018.12.012
- Tømte, C., Enochsson, A. B., Buskqvist, U., & Kårstein, A. (2015). Educating online student teachers to master professional digital competence: The TPACK-framework goes online. *Computers and Education*, 84, 26–35. doi: 10.1016/j.compedu.2015.01.005
- Tondeur, J., Aesaert, K., Prestridge, S., & Consuegra, E. (2018). A multilevel analysis of what matters in the training of pre-service teacher's ICT competencies. *Computers and Education*, 122, 32–42. doi: 10.1016/j.compedu.2018.03.002
- Tondeur, J., Scherer, R., Siddiq, F., & Baran, E. (2017). A comprehensive investigation of TPACK within pre-service teachers' ICT profiles: Mind the gap! *Australasian Journal of Educational Technology*, 33(3), 46–60. doi: 10.14742/ajet.3504

- Tseng, J.-J., Cheng, Y.-S., & Yeh, H.-N. (2019). How pre-service English teachers enact TPACK in the context of web-conferencing teaching: A design thinking approach. *Computers & Education*, 128, 171–182. doi: 10.1016/j.compedu.2018.09.022
- Tsybulsky, D., & Levin, I. (2016). SAMR Framework for Study Technology Integration in Science Education. In *New Perspectives in Science Education*. Retrieved September 26, 2019, from <http://m.tau.ac.il/~ilia1/perspectives-florence.pdf>
- Uerz, D., Volman, M., & Kral, M. (2018, February 1). Teacher educators' competences in fostering student teachers' proficiency in teaching and learning with technology: An overview of relevant research literature. *Teaching and Teacher Education*, Vol. 70, pp. 12–23. doi: 10.1016/j.tate.2017.11.005
- Valtonen, T., Sointu, E., Kukkonen, J., Kontkanen, S., Lambert, M. C., & Mäkitalo-Siegl, K. (2017). TPACK updated to measure pre-service teachers' twenty-first century skills. *Australasian Journal of Educational Technology*, 33(3), 15–31. doi: 10.14742/ajet.3518
- Vinck, D. (2018). *Humanidades Digitales*. Barcelona, España: Gedisa.
- Wang, J., Tigelaar, D. E. H., & Admiraal, W. (2019). Connecting rural schools to quality education: Rural teachers' use of digital educational resources. *Computers in Human Behavior*, 101, 68–76. doi: 10.1016/j.chb.2019.07.009
- Wu, B., Hu, Y., Gu, X., & Lim, C. P. (2015). Professional Development of New Higher Education Teachers with Information and Communication Technology in Shanghai. *Journal of Educational Computing Research*, 54(4), 531–562. doi: 10.1177/0735633115621922
- Xiong, X. B., & Lim, C. P. (2015). Curriculum Leadership and the Development of ICT in Education Competencies of Pre-service Teachers in South China. *Asia-Pacific Education Researcher*, 24(3), 515–524. doi: 10.1007/s40299-015-0238-1
- Yildiz, T. (2016). The exploration of the relationships between the global competitiveness, the ICT and education. *Business, Management and Education*, 14(2), 249–274. doi: 10.3846/bme.2016.320