International Journal of Advanced Engineering Research and Science (IJAERS)
Peer-Reviewed Journal
ISSN: 2349-6495(P) | 2456-1908(O)
Vol-9, Issue-8; Aug, 2022
Journal Home Page Available: https://ijaers.com/
Article DOI: https://dx.doi.org/10.22161/ijaers.98.16

Pedagogical models focused on the integration of ICT in basic education: A systematic review

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Received: 12 Jul 2022,

Received in revised form: 01 Aug 2022,

Accepted: 07 Aug 2022,

Available online: 12 Aug 2022

***Keywords*— Pedagogical model, Digital Information and Communication Technologies, Basic Education.**

***Abstract*—** *A pedagogical model is a system of theoretical premises that organize a curricular approach, being incorporated into teaching practice and the interactions between teacher, student, and learning object. In teaching practice, their interaction with students should be based on activities that seek to contextualize with reality. On the other hand, pedagogical practices, based on the implementation of Digital Information and Communication Technologies, improve the performance of teachers who develop skills to plan modern and technology-integrated learning processes. This article presents a systematic review of works published in the period 2018-2022 that dealt with the use of pedagogical models based on the integration of TDIC in basic education. From the 10 works identified, it was possible to conclude that a pedagogical model must use the technological approach to meet the needs of the teacher and their students. The research contributed to finding the main and most recent studies on the subject. In this way, the article serves as a summary of publications on pedagogical models in TDIC carried out in the period 2018-2022.*

I. INTRODUCTION

Teaching strategies in an educational environment are fundamental tools to develop students' cognition, metacognition, and emotional processes. The use of these strategies allows students to understand and build knowledge with autonomy and responsibility that meets their particularities. Therefore, the teacher has a fundamental role for students to be able to engage in their learning. This occurs mainly when the educator structures the activities and the pedagogical environment dynamically, with the participation of all subjects [15].

Camargo and Daros [18] argue that pedagogical activities should be reality-oriented and develop useful skills for the student's personal and professional fulfillment. For the authors (CAMARGO & DAROS, 2018), students must learn cognitive strategies and skills inherent to each application of knowledge. In this way, they obtain the ability to build knowledge applicable to their realities. Therefore, Camargo and Daros [18] also indicate the need to develop digital skills, as these become an increasing need in our society.

In turn, digital skills enable the implementation of Digital Information and Communication Technologies (TDIC) as contributing instruments for this learning process [17]. For Bacich and Moran [3], education must be reformulated by analyzing the contributions, risks, and changes arising from the interaction with digital culture,

the interaction of TDIC, resources, interfaces, and media languages to teaching practice. Thus, exploring the potential of integration between professional, cultural, and educational spaces for the creation of authentic contexts based on technology.

It is worth noting that the pedagogical practices, adopted from the implementation of TDICs in teaching, improve the involvement of students, who develop skills to plan processes and procedures related to their learning [21]. Consequently, the interaction between students, teachers, and the school environment is modified by the inclusion of technological resources, creating conditions for the teaching and learning process to occur mutually between educator and student [21].

An important tool that helps in the development and execution of pedagogical strategies is the Pedagogical Model (PM). Behar [4] defines PM as a system of theoretical premises that represent, explain and guide a curricular approach and are incorporated in teaching practice and the interactions between teacher, student, and learning object. In this social relationship, the subject will act according to the defined model.

The use of Pedagogical Models for the integration of TDIC can help students develop the technical knowledge necessary to use these technologies. To integrate with the TDICs, the MP must place the student at the center of the learning process, enabling interaction with the world, and the construction and development of knowledge from the possibilities offered. [22]

This article aims to carry out a systematic review on the application of pedagogical models focused on the integration of TDIC in Brazilian basic education.

This article is divided into four sections. The first section, Introduction, is dedicated to presenting initial concepts about the researched topic. The second section, Methodological Procedures, presents the research techniques and methods for the development of this research. In the third section, Results, and Discussions, data analysis and interpretation are performed. Finally, the conclusion is presented.

II. METHODOLOGICAL PROCEDURES

To carry out this research, technical procedures that have the classification of the systematic review were adopted. This type of review identifies and minimizes bias through a transparent, explicit, and systematic methodology. In this sense, Khan et al [13] present five main steps for carrying out a systematic review:

Table 01. Systematic Review Steps

Stage	Description
1	Develop guiding questions
2	Identify relevant work
3	Analyze the quality of studies
4	Summarize the evidence
5	Interpret the findings

In step 1, the guiding questions must be elaborated, that is, problems that the systematic review seeks to solve. Subsequently, it is necessary to identify relevant works already carried out on the subject. The third step is to individually and thoroughly analyze the quality of the studies found to prepare a summary of the evidence of each one, according to step 4. Finally, the findings must be interpreted, characterized by the results of the systematic review carried out [13].

The guiding question for the present research is to "identify the most recent works that present pedagogical models that integrate TDIC in basic education".

To obtain the portfolio of articles to be analyzed in this research, systematic search criteria were used, based on Khan et al [13]. Therefore, the following keywords were used: “Pedagogical Model "; “Digital Technologies” or “Digital Technology” or “ICT” or “Information and Communication Technologies” or “TDIC” or “Digital Information and Communication Technologies”; and “Basic Education". The databases used were IEEE Xplore, Scopus, and Springer.

In this bias, filters were applied to delimit the search. The search was for publications related to the years 2018 to 2022, intending to emphasize the most recent studies on the subject. The types of publications filtered were conference documents, articles, dissertations, and theses. In addition, it was necessary to use documents with free access and complete availability of the text. The search results in the databases were 5 publications in IEEE Xplore, 7 publications in Scopus, and 326 in Springer, totaling 338 studies. Table 02 presents the results found:

Table 02. Systematic Search Results

Specifications		Database results			Total
		IEEE Xplore	Scopus	Springer	
String	(“Pedagogical Model”) AND (“Digital Technologies” OR “Digital Technology” OR “ICT” OR “Information and Communication Technologies” OR “TDIC” OR “Digital Information and Communication Technologies”) AND (“Basic Education ”)	5	7	326	338
Publication Type	Conference articles Magazine articles Dissertations and Theses				
Publication date	2018 to 2022				
Other filters	Open access Full text available				

Donato [9] explains that in a systematic review it is essential to define the studies that will be selected and those that will be excluded. For this, it establishes 5 steps, starting with the analysis of the relevance, later reading the titles and abstracts to remove studies that are not related to the topic, exclusion of duplicate works, reading the introduction and conclusion, and finally, the complete reading.

The following section, Results, and Discussion will present the filtering process applied in the present research.

III. RESULTS AND DISCUSSION

This section presents the results found and discusses what was discovered. The results were subjected to five exclusion criteria, as shown in the table below:

Table 03. Exclusion Criteria

Specifications	Results in databases			Total
filters	IEEE Xplore	Scopus	Springer	
1 Analysis of relevance	5	7	326	338
2 Reading the title and abstract	5	7	154	166
3 Deleting duplicate jobs	5	5	72	82
4 Introduction and conclusion reading	1	0	21	22
5 full reading	1	0	9	10

Source: authors

When reading the titles and abstracts, results that did not have objectives aligned with the study theme and duplicated results were excluded, leaving 82 works. The introduction and conclusion were read, classifying 10 relevant works for a complete reading.

Description of publications found

The second study analyzed, by Ilomäki and Lakkala [11], aimed to create a model that describes the main elements to improve schools using digital technology,

helping to reveal the differences between schools, and identifying their best practices and challenges. The applied model was based on six main elements that describe an innovative digital school: school visions, leadership, teaching practices, pedagogical practices, school-level knowledge practices, and digital resources. The application took place in three basic education schools and the results indicate essential differences between the schools and their best practices and points of improvement.

Kaminski et. al. (2019) built their research around the existing framework of the Writer's Workshop [1]to create a new framework to support learning that takes place in a makerspace environment. This article provides academics and practitioners with a guide to teaching and learning that can be customized to suit different aspects of STEAM content [2]to the unique circumstances of the school environment, and can be used in an everyday context and as a large-scale interdisciplinary STEAM initiative.

Avsec and Sajdera [2] use a pedagogical model for " *engineering thinking* ", which is a variation of " *design thinking* [3]", but more focused on engineering concepts. They tested this pedagogical model with 154 preschool teachers from Slovenia and Poland. According to the authors, they were looking for a tool to improve the creative potential of teachers, as well as their attitudes regarding the use of technology at school. According to Avsec and Sajdera [2], the pedagogical model was effective in deconstructing paradigms regarding the use of technology in preschool. The authors indicate that pedagogical models based on *engineering thinking* are positive especially in preschool and early grades.

The article by Kadıoğlu-Akbulut et al [12] aims to develop a valid and reliable *ICT-TPACK-Science Scale* based on the transformative model, taking into account recent improvements in educational technologies specific to science teaching. The *ICT-TPACK-Science* Scale is a reliable and valid instrument to measure the TPACK of science teachers in training. This study included 722 science professors from 12 universities in Turkey. This has resulted in a scale that can be used to examine and support the development of TPACK. The scale is administered periodically in teacher training institutions to design and implement support strategies.

Falloon [10], in his article, presents an expanded conceptual framework of the teacher's digital competence. The research goes beyond technical conceptualizations to advocate for a more holistic and broad understanding, recognizing the need to expand teacher-in-training's understanding of the kind of competencies needed to function productively, safely, and ethically in diverse environments, including the digital one. The result is a comprehensive digital competency framework for teachers that will help build pedagogical models and take advantage of digital resources.

Another article analyzed was by Kamaludin et al [1]. The study developed a model to examine the factors that influence the behavioral intention of teachers and the actual use of the blended learning modality based on the Unified Theory of Acceptance and Use of Technology and the Technological, Pedagogical and Content Knowledge model. The survey was applied through questionnaires with 544 academic staff at universities, colleges, and polytechnic centers. The main result found was that the expectation of performance, effort, and social influence significantly impact the behavioral intention of teachers to use a hybrid learning modality for teaching.

In a study on digital pedagogical models, Brink, Kilbrink, and Gericke [6] seek to investigate teachers' experiences with these models. This study carried out 12 semi-structured interviews with technology teachers. The results show that technology teachers teach with different goals and purposes, whether improving and integrating other disciplines, visualizing technology for students, enabling digital modeling, and preparing students for the future. As technologies evolve rapidly, there is no single way to experience teaching digital pedagogical models, as these can also change over time.

In the article by Çam and Koç [7], they analyzed the impressions of teachers in training on the practices of Technological Knowledge of Pedagogical Content (TPACK) in higher education. The research was carried out using the case study method and with it, 7 educators in training received training and were asked to carry out practices. According to the survey results, the teachers in training showed a positive attitude towards the courses carried out according to the TPACK. The TPACK practical activities caught the attention of teachers during training, who actively participated in the practical activities. Finally, they reported that traditional teaching methods had lost attention and wanted novelties that they could use when they became teachers.

[1]The process-oriented framework allows students autonomy and choice while providing a framework to meet specific literacy standards as they engage in the creative act of writing, allowing students to take turns with activities such as giving and taking peer feedback, talking to the teacher, and reviewing (KAMINSKI ET.AL., 2019).

[2]Application of specific knowledge of Science, Technology, Engineering, Arts, and Mathematics (KAMINSKI ET.AL., 2019).

[3]Process of generating ideas in a multidisciplinary group with a focus on problem-solving [5].

Foulger et al [5] present a form called IT2 (Teach with Technology) Survey. They demonstrate the tool as an effective instrument to examine factors associated with contextual knowledge and their influence on technology integration. For the authors, the form is considered part of a pedagogical model based on contextual learning.

In the last study analyzed, Jong et al [8] present an informed account of the Go-Lab, an ecosystem that supports teachers in creating Inquiry Learning Spaces (ILSs). Within the Go-Lab ecosystem, teachers can combine these online labs with multimedia material and learning apps, which are small apps that assist students in their inquiry-based learning process. For the article, data on the design process and structure of 2,414 ILSs were analyzed and the results found show that about 20% of implemented ILSs came from the Go-Lab sharing platform. This means that most originated from an empty ILS that the teacher fills with materials. Another important result is that 51.12% of the implemented ILS were created by a single teacher and 48.33% were created in teamwork.

IV. CONCLUSION

The objective of this research was to search for recent studies that addressed the themes Pedagogical Model, Digital Information and Communication Technologies, and Basic Education. For this search, the technical procedure of systematic review was adopted.

After applying filters and exclusion criteria, 10 articles published in the period from 2018 to 2022 were analyzed in full. The findings show that several pedagogical models were tested by teachers at the most diverse levels of education. In applied research, it was observed that teachers or teachers in training are more adept at using Information and Communication Technologies in the classroom. From the reading of the publications found, it was possible to verify that the pedagogical models that include TDICs gained strength compared to traditional methods, which has a positive impact on student performance.

One can observe the need for the pedagogical models adopted by teachers to seek to contemplate innovative strategies to adapt to current trends and increase the relevance of learning. An innovative MP must utilize the technology approach to meet the growing needs of learners for knowledge acquisition, skills training, and lifelong learning.

In general, this research contributed to finding the main and most recent studies on Pedagogical Models linked to Digital Information and Communication Technologies.

ACKNOWLEDGEMENTS

Acknowledgments: This work was carried out with the support of the Fundação de Amparo à Pesquisa e Inovação do Estado de Santa Catarina (FAPESC), through resources from the Public Call Notice FAPESC/CAPES Nº 21/2021 – Accreditation of Higher Education Institutions with emerging stricto sensu graduate programs and being consolidated in priority areas in the state of Santa Catarina, Termo de Grant CP 21/2021 FAPESC.

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