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ARTIGO

INTEGRATION OF TECHNOLOGY IN EDUCATION: PROPOSAL FOR A TEACHER TRAINING MODEL INSPIRED BY TPACK

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ABSTRACT: Technological integration is typically understood as the incorporation of technology in classrooms. However, a key point of concern is how this inclusion has been made in the teaching process, learning experiences, and curriculum. Thus, it is possible to assert that the integration of ICT in the classroom involves specific teachers' skills concerning the pedagogical use of technologies. Teachers need to acquire and develop continuous relevant knowledge, competencies, and attitudes in order to include technological resources in their daily tasks. This research presents the initial stage of a framework for technology integration in education, which is part of the Program of Technology Integration in Education, developed by the Remote Experimentation Laboratory, at the Federal University of Santa Catarina. At this specific stage, a survey was conducted to understand the level of knowledge and experience in ICT of the participating teachers' in their classes. Two questionnaires made available in the Virtual learning environment were answered by 398 teachers from five schools during the initial teacher training course between 2017-2019. This study has enabled us to understand the participating teachers' perspectives on the use of technologies. It is possible to affirm that the presented training framework has been effective in enabling teachers to learn how to use technologies in the classroom and in helping them reflect on their pedagogical practices.

Keywords: Educational technology. Secondary education. Teacher training. TPACK.

INTEGRAÇÃO DE TECNOLOGIA NA EDUCAÇÃO: PROPOSTA DE MODELO PARA CAPACITAÇÃO DOCENTE INSPIRADA NO TPACK

RESUMO: A integração tecnológica geralmente é entendida como a incorporação de tecnologia nas salas de aula. No entanto, um dos pontos que merece mais atenção é a forma como essa inclusão tem sido feita no processo de ensino, nas experiências de aprendizagem e no currículo. Assim, é possível

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afirmar que a integração das Tecnologias de Informação e Comunicação (TIC) na sala de aula envolve competências específicas dos docentes em relação ao uso pedagógico das tecnologias. Os professores devem adquirir e desenvolver continuamente conhecimentos, habilidades e atitudes pertinentes à área no intuito de incluir os recursos tecnológicos em suas tarefas diárias. Este estudo abordou a etapa inicial de um framework de integração de tecnologia na educação, que é parte do Programa de Integração de Tecnologia na Educação, desenvolvido pelo Laboratório de Experimentação Remota, na Universidade Federal de Santa Catarina. Neste estágio específico, conduziu-se uma pesquisa com o objetivo de conhecer o nível de conhecimento e experiência dos docentes participantes no que se refere ao uso de TICs em suas aulas. Dois questionários, disponibilizados no Ambiente Virtual de Ensino e Aprendizagem, foram respondidos por 398 professores de cinco escolas durante o estágio inicial das capacitações ofertadas pelo programa entre 2017-2019. Este estudo permitiu conhecer a visão dos docentes participantes quanto ao uso de tecnologias. É possível afirmar que o framework de formação tem se mostrado eficiente, uma vez que tem possibilitado aos professores aprenderem a utilizar as tecnologias em sala de aula bem como a refletir sobre as suas próprias práticas pedagógicas.

Palavras-chave: Tecnologia educacional. Educação Básica. Capacitação docente. TPACK.

INTEGRACIÓN DE TECNOLOGÍA EN EDUCACIÓN: PROPUESTA DE UN MODELO DE FORMACIÓN DE PROFESORES INSPIRADO EN TPACK

RESÚMEN: La integración tecnológica, aunque sea generalmente comprendida como la existencia de tecnología en los salones de clases, en verdad tiene como principal problema la necesidad de centrarse en cómo será esta inclusión al proceso de enseñanza, a las experiencias de aprendizaje y al currículo. Así, es posible afirmar que la integración de las Tecnologías de Información y Comunicación (TIC) en el salón de clase va por medio de competencias específicas de los docentes, cuanto al uso pedagógico de las tecnologías. Por lo tanto, los docentes deben tener conocimientos, habilidades y actitudes relevantes y que puedan desarrollarlas para incluir recursos tecnológicos en sus tareas diarias. Este estudio abordó la etapa inicial del framework de integración de tecnología en educación del Programa de Integración de Tecnología en Educación, del Laboratorio de Experimentación Remota, de la Universidad Federal de Santa Catarina. Esta etapa consistió como un diagnóstico, con el objetivo de conocer el grado de formación y uso de las TIC en clase por una parte de los docentes participantes. Los instrumentos utilizados fueron dos cuestionarios en línea, disponibles en el Ambiente Virtual de Enseñanza y Aprendizaje y que fueron respondidos durante el curso inicial de capacitación de los docentes. Los datos presentados en este documento se refieren a 398 profesores, de cinco escuelas, que participaron en las actividades de capacitación del programa entre 2015-2019. Este artículo permitió conocer la opinión de los docentes que participaron en la investigación sobre el uso de tecnologías. Es posible afirmar que el modelo de formación de la investigación ha demostrado ser eficiente, ya que ha posibilitado a los profesores solamente aprender a utilizar las tecnologías en el salón de clase y reflexionar sobre sus propias prácticas pedagógicas.

Palabras clave: Tecnología educacional. Educación Básica. Capacitación docente. TPACK.

INTRODUCTION

The proximity between Information and Communication Technologies (ICT) and the educational world is evident, although sometimes this proximity responds more to pressures external to the educational institution (related to the phenomenon of the consumer society and its successive trends) than to effectively didactic and educational approaches. Although technological integration is generally understood as the existence of technology in classrooms, in fact, the main problem must focus on how this technology will be included in the teaching process, learning experiences and the curriculum. Therefore, when talking about educational innovation with ICT, we should keep in mind it is not based on the growing and indiscriminate use of new technologies, but on the development of pedagogical practices consistent with their use in the classroom.

According to Wenglinski (2005), educational technology should not be seen as an isolated phenomenon, but be considered a piece of the puzzle of how teachers teach and students learn.

Thus, many educational researchers indicate the integration of technology in the classroom may be advantageous for students and teachers. For example, technology can help motivate students and provide them with important skills to reinforce their learning (BISSELL, 1998; BURNS, 2006; FELDSTEIN, 1988; NOVEMBER, 2010; PROJECT TOMORROW, 2010).

Educational innovation through ICT involves a practical knowledge of the limits and possibilities the protagonism of those can have in the teaching and learning processes. According to Haşlaman et al. (2007), when ICT is integrated into the teaching and learning processes, this means that:

− teachers will plan and design effective ICT-supported learning environments and experiences;

− teachers will create appropriate learning opportunities for the implementation of ICT-enriched teaching strategies in order to support pupils' needs; and

− apply education plans containing the methods and strategies necessary for the use of relevant technologies.

Unquestionably, the integration of ICT in the classroom involves specific competencies of teachers in relation to the pedagogical use of these technologies. Therefore, in order for the integration of these resources in the classes to be more effective, it is necessary that teachers have relevant knowledge, skills and attitudes and that they can develop them in order to include technological resources in their daily tasks. This implies that the teacher must know them in their dimensions, be able to critically analyze them and make an adequate selection, both of the technologies and of the information they convey, being able to use them and perform an adequate curricular integration in the classroom.

É possível então afirmar que as TIC afetam o perfil do docente na medida em que lhe exigem capacitação para sua utilização, além de cobrar destes uma atitude aberta e flexível ante às mudanças contínuas que ocorrem na sociedade como consequência do avanço tecnológico. For many authors, one of the biggest difficulties when it comes to implementing ICT in the classroom is to define what technology will be used for instead of knowing how to use a tool.

The report Educators, Technology and Skills of the 21st Century, published by Walden University, indicates that the problem is often the difficulty of teachers in integrating technology into their class, which is related to initial training. The document shows many teachers believe their initial training has not prepared them well for any technology or skills of the 21st century.

Data from 2018's ICT in Education survey, conducted by the Internet Steering Committee in Brazil (CGI.br), concerning teachers working in urban schools, indicated that (CGI.BR, 2019):

− 55% did not attend, in graduation, any discipline on the use of computer and Internet in teaching activities;

− 70% did not participate in continuing education on the use of computer and internet in teaching activities;

- 90% of teachers, when asked about how to learn and update on the use of computer and internet, answered “alone”.

In order to achieve success in technology integration initiatives in education, teachers must be able to critically analyze them, make an adequate selection of both technological and information resources they convey, be able to use them and perform an adequate curriculum integration in the classroom. The data presented above indicate deficiencies in the training of teachers in relation to the pedagogical use of ICT. These shortcomings will constitute barriers to the integration of ICT into their lesson plans. In this sense, the 2018 ICT in Education survey, on the barriers perceived by teachers of urban schools, for the use of ICT in the

TECHNO-EDUCATIONAL MODELS

The inclusion of technologies in educational practice is not always homogeneous. While in some institutions it is received with enthusiasm, in others it is received with uncertainty, although there is consensus on the importance of its integration into the teaching and learning processes. The literature presents several models for the integration of ICT in education. These models seek to meet the didactic level of ICT and are related to different moments in the use of those in educational processes. Among the various models mentioned in the literature, the following may be included: ADDIE, ARCS, ASSURE, HYFLEX, THE DICK AND CAREY, ACOT, COI, ICM-FCM, ITL LOGIC, TIM, CONNECT, CLEs, FSM, OILM, SAMR and TPACK (GÁMEZ, 2015).

The models oriented to instructional design or Distance Learning seek to define the instructional process as a system and present several actions or related steps aimed at the development of an orderly and compact educational process. In this line of models we can mention: ADDIE, ARCS, ASSURE, HyFlex and Model "The Dick and Carey Systems Approach Model".

ADDIE, whose name is due to the adoption of the initial letter of each of its five phases - analysis, design, development, implementation and evaluation - is a model commonly used in instructional design. It was developed in the 1970s and, according to Robin and McNeil (2012), without specific authorship. ADDIE has been used in both education and industry (ROBIN; MCNEIL, 2012; GÁMEZ, 2015).

ARCS Model (attention, relevance, confidence and satisfaction) was presented in 1987 by John Keller, and had its last version presented in 2009 in the book: Motivational Design for Learning and performance. This model is based on the idea that there are personal and environmental characteristics that can influence motivation, and, therefore, the return to educational objectives. Its design allows a great applicability in virtual technology surroundings, and has been used as basis for the implementation of several research projects (HUETT; KALIWSKI; MOLLER; CLEAVES, 2008; JONES, 2010; LEE; KIM, 2012; GÁMEZ, 2015).

ASSURE instructional model was developed in 1992 by Robert Heinich, Michael Molenda and James D. Rusell. It is a model based on Robert Gagné's theory of learning and takes into account the nine events of instruction and cognitive processes proposed by the author. I.e.: (i) get attention (reception); (ii) inform the objective for the apprentices (expectation); (iii) stimulate the memory of previous learning (recovery); (iv) present the stimulus (selective perception); (v) provide learning guidance (semantic code); (vi) elucidate performance (response); (vii) provide feedback (reinforcement); (viii) evaluate performance (recovery) and (ix) increase retention and transfer (generalization). The word ASSURE is an acronym for representing six phases of instructional drawing: A (Analyze learners); S (Set the objectives); S (select the 3 M's: means, methods and materials) ; U (Utilize the 3 M's); R (Require learner participation) and E (evaluate and review) (GÁMEZ, 2015).

The HyFlex model was proposed by Brian Beatty in 2006 at the 2006 International Annual Technology Convention of the Association for Educational Communication. The words Hybrid and Flexible, which make up the model name, give a general idea of what the author tries: to offer the student learning experiences, whether virtual or face-to-face. This constitutes a proposal that provides b-learning courses with characteristics of adaptation and flexibility in relation to the individualities to learn and the time required by students. It is a very important model in the field of technology-mediated education (GÁMEZ, 2015).

The Dick and Carey Systems Approach Model was presented in 1978 by Walter Dick, Lou Carey and James O. Carey. Its authors proposed it as a model for distance learning. Its flowchart describes a process of 10 steps or main components to support the design, development, execution and evaluation of teaching, which, in turn, respond to a predetermined order with a close relation between the realization of each of them, where the previous step of the model in general establishes "a systemic process that refers to its components as a set of interrelated parts, which together are directed to a defined goal and each system depends on the whole system" (MARTÍNEZ, 2009).

Models oriented to the development of environments can be identified as those directed to the development of learning environments directed to specific use. Among these, the following models may be highlighted: ACOT, IOC, ICM-FCM, ITL LOGIC and TIM.

Apple Classrooms of Tomorrow (ACOT) emerged as a collaborative and research project between public schools, universities, and research agencies, with the support of Apple Computer, Inc., which shows excellent results, around 1995. The ACOT proposed the use of technology by teachers and students as a factor of change in teaching-learning processes. The project, which has now evolved into ACOT2 (Apple Classrooms of Tomorrow - Today), has been identified as an effective teaching-learning model with technological support, professional teacher development and dissemination of innovation (APPLE INC., 2008). The phases that make up the ACOT model are Introduction, Adoption, Adaptation, Appropriation and Invention and are represented in Figure 01 (DWYER, 1995).

Figure 1 - ACOT model.
Source: Adapted from Dwyer (1995).

The CoI (Community of Inquiry Framework) model was developed by Garrison, Anderson and Archer (2000), and has been one of the much-referenced techno-educational models in recent years. It is a model created for e-learning environments, which proposes an effective design of educational experience in online learning environments and is based on social learning in community, collaborative learning, instructional design, social constructivism and distance education (TEKINER; SHUFORD, 2013). It seeks to share Vygotsky's vision (1978) in his constructivist character according to the function of language and discourse as a means of sharing the construction of meanings.

Inverted or Flipped Classroom Model (ICM/FCM)[4]. As the name implies, ICM/FCM suggests the reversal of moments and roles in traditional teaching, where the activities that the teacher traditionally transmits can be assisted in extra hours by the student through online tools and classroom activities performed through interactive methods of collaborative work, problem-based learning and project realization (LAGE; PLATT; TREGLIA, 2000; TALBERT, 2012; GÁMEZ, 2015).

The Innovative Teaching and Learning (ITL) Logic Model was developed by the Stanford Research Institute (SRI) in 2009. This model seeks to generate new life and work skills in basic education students, based on a perspective of change in educational policies, change in school leaders and cultures that will be reflected in innovative educational practices. ITL's Logical Model defends the premise that

[4] The term inverted classroom was originally coined by Lage, Platt and Treglia (2000) as inverted classroom (IC) and was used to detail the class strategy implemented in a specific discipline (Economics), although it refers to the use of similar techniques in all the subjects in which the teacher requests the approach of specific topics before class (TALBERT , 2012; TUCKER, 2012).

ICT alone cannot transform education, they must be integrated from a national perspective and the teaching practices should be pedagogically focused on student learning (LANGWORTHY, 2014)

The Technology Integration Matrix (TIM) model was developed by Jonassen, Howland, Moore and Marra (2003) and adapted by the Florida Center for Educational Technology and the University of South Florida School of Education in 2011. TIM is characterized by the application of personal computers, laptops, smartphones, tablets, interactive whiteboards, voice recorders, online tools such as webquest, letterpop, among others, as well as videos and audios. ICT tools allow education, space, location and time to adapt to users. In the TIM Model, the interaction between teacher and student is only mediated and not replaced by ICT, providing an environment enriched in activities, research, proposals, participation, exchange of forms of study between peers, regardless of sharing physical or virtual spaces. However, the correct way of teaching can overcome the incorrect choice of ICT, but these cannot replace bad teaching (BATES, 2005; GÁMEZ, 2015).

The designed learning environments based on TIM model have the characteristics of Figure 02.

ATIVO
COLABORATIVO
CONSTRUTIVO
AUTÊNTICO
OBJETIVOS DIRIGIDOS

Figure 2 - Characteristics of learning environments in the TIM model.
Source: Translated from the Technological Integration Matrix (http://fcit.usf.edu/matrix/index.php).

In the latter group, the one with models favoring the use of various technological resources, some models that address the use of diverse technological resources or means are mentioned. Some based mainly on constructivist theories and collaborative learning. In this group, the following models were addressed: CONNECT, CLEs, FSM, OILM, SAMR and TPACK.

The CONNECT model suggests that contexts and learning methods should be mixed. It defines the use of the contextual learning model, where the importance of the students' personal, physical and sociocultural contexts is fundamental; specifically defines the role of free choice of this type of learning. The model originated from CONNECT, which was co-financed by the European Commission under the IST - Information Society Technologies program (AGOGI, 2006). In the CONNECT model, the objective was to implement the activities proposed in schools by teachers and educators, which were originally conceived under the concept of informal learning obtained in museums and scientific parks (GÁMEZ, 2015).

The Constructivist Learning Environments (CLEs) model was developed by David Jonassen in 1999 and its main objective is to promote problem solving and conceptual development; as well as emphasizing the role of the student in the construction of knowledge (learning by doing). CLEs uses instructional design as a model to design environments involving students in the development of knowledge, through the implementation of the elements that constitute it.

The FSM (Five Stage Model of E-learning) was developed by Gilly Salmon in 2000 and consists of five periods or phases to develop virtual learning with the aid of a moderator. Its project represents stairs in which each step expresses academic, technical and moderation skills enrolled with learning and education in a virtual community. where they are all related to each other through the interaction between their elements. The theoretical basis of the model consists of: Vygotsky's Zone of Proximal Development, Constructivism and Cooperative Learning (ABDULLAH; HUSSIN; ASRA; ZAKARIA, 2013; GÁMEZ, 2015).

The Online Interaction Learning Model (OILM) was proposed by Benbunan-Fich, Hiltz and Harasim in 2005. This model has been used as theoretical reference for online courses and as a technopedagogical model in higher education. The model is based on the constructivist learning theory, which promotes the practice, discovery and validation of knowledge by the student (BENBUNAN-FICH et al., 2005). Promoting the combination of student participation with interpersonal group processes, the authors of the model state that these interactions are related as the collaborative learning pedagogy is used.

The Substitution, Augmentation, Modification and Redefinition (SAMR) model was developed by Rubén R. Puentedura and presented for the first time at MERLOT4 International Conference (PUENTEDURA, 2003). SAMR consists of a hierarchical set of 4 levels that allows one to evaluate how technologies are used by teachers and students in classes. Its goal is to help teachers evaluate how they are incorporating technologies into their classrooms and thus knowing what kind of technology use has a greater or lesser effect on students' learning (PUENTEDURA, 2012). Figure 03 shows the four levels that make up the SAMR model. As it is seen, the first two levels imply a technological improvement and the last two imply a technological transformation.

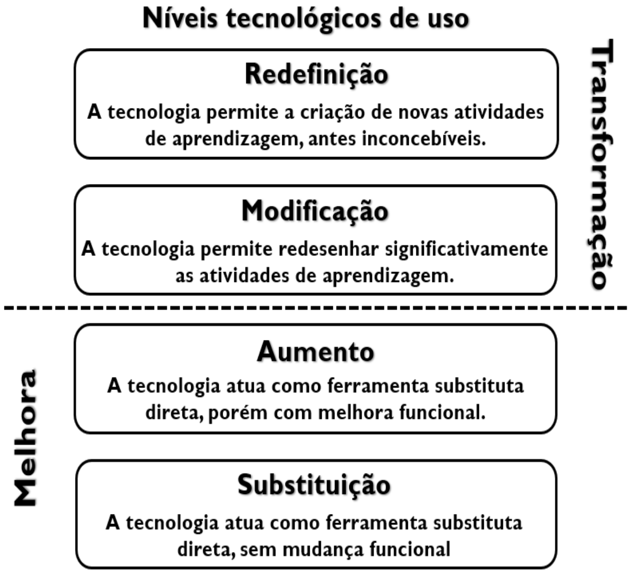

Figure 3 - SAM Model.
Source: Own translation from Puentedura (2012).

This section concludes with TPACK (Technological Pedagogical Content Knowledge) model. This model was developed between 2006 and 2009 by professors Punya Mishra and Mattew J. Koehler of Michigan State University. The proposal has its initial beddings in PCK approach developed by Shulman (1986, 1987) and to which was added the term “Technology” (t), to the already existing “Pedagogy” (P) and “Curriculum Content” (C). Considering the contributions by Koehler and Mishra (2006) to an effective teaching practice and conversations about good practices, they should be based on three basic components: Curriculum content (CK - Content Knowledge), Pedagogy (PK - Pedagogical Knowledge) and Technology (TK - Technological Knowledge) and all interactions established between these components. The interactions between these components (CK, PK, and TK) are the basis of the TPCK model.

The authors Mishra and Koehler (2009) state that the three areas of knowledge should be interrelated: According to Mishra and Koehler (2006, p. 1026), Content (CK) located in the field of knowledge, discipline or discipline taught and learned "[...] is knowledge about the subject to be taught or learned." Pedagogical knowledge (PK) aimed at teaching and learning processes, general objectives, values and goals of education and technology (TC) focused on the assimilation of ICT to apply them to work and daily life. This knowledge originates in the fields of Pedagogy, Didactics, among others, being applied in the student's learning. And Technological Knowledge (TK), which covers traditional technologies or digital technologies (MISHRA; KOEHLER, 2006)

These relations give rise to four factors: Pedagogical content knowledge (PCK); technological content knowledge (TCK); Technological Pedagogical Knowledge (TPK); aimed at obtaining the Technological Pedagogical Content Knowledge (TPACK), where the teacher's knowledge is linked and evaluates his/her competencies to transmit a given discipline, all with a significant approach related to the context of interaction (KOEHLER; MISHRA, 2009). Figure 04 identifies the three sets of knowledge that interact with each other and among the three, constituting new types of knowledge.

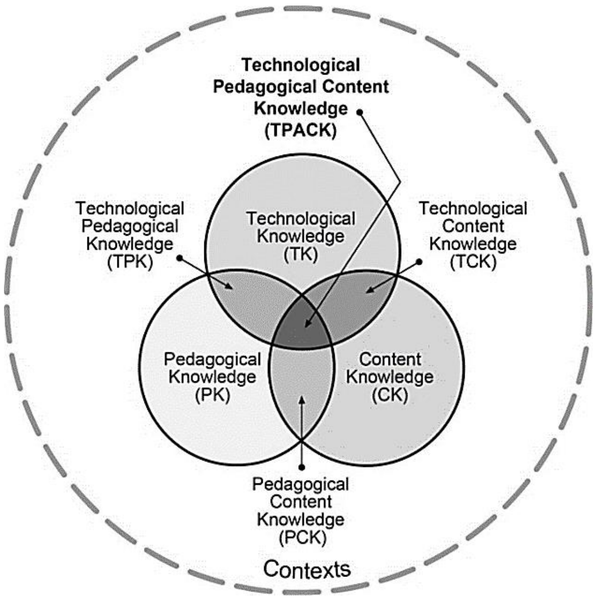

Figure 4 - Model TPACK.
Source: Based on http://www.tpck.org/

The Technological Pedagogical Content Knowledge (TPACK) is a model that seeks to identify the types of knowledge a teacher needs to master to integrate ICT in an effective way in his teaching process. Its main objective is the articulation of the three knowledges that form its basis (CK, PK and TK), in order to be successful in teaching and learning objectives.

The TPACK can be understood as a set of strategies that integrate technologies in the classroom, being the teacher's association of technological knowledge (TK), pedagogical knowledge (PK) and content (CONTENT Knowledge - CK) necessary. Thus, it is a pedagogical model in which the teacher can use certain actions that can be based on the use of technologies in education. However, although to consider the integration of the TIC in the schools, the current results, as pointed previously, they demand new investigations and the necessity to consider as the programs of application of the TPACK could better support practical the pedagogical ones of the professors (KOH, 2019).

According to Harris et al. (2009), it is very important that teachers try to understand TPACK's domains, its contexts and correlations. It is noteworthy there is no single or magical technological solution, which will work in all contexts (teacher, course or pedagogical approach). The success for the integration of technology in the educational field is directly related to the flexibility and ability to travel through the fields of content, pedagogical and technological knowledge, as well as the interactions between them. Ignoring the complexity inherent in each component of knowledge or its relationships will fatally lead to the failure of the initiative.

It is essential that teachers develop fluency in the main domains (content, technology and pedagogy) and not only in one or part of them. By being able to understand how these domains are interrelated, teachers will be expanding the possibilities of success. For example, TPACK considers that technical knowledge is essential for teaching and learning, however, it is not enough to promote changes in the ways of teaching and learning, since other knowledge is needed by teachers. Teachers who choose teaching and learning mediated mainly by digital technologies should consider the integration and overlap of TPACK's domains and subdomains, working them in uniqueness (HARRIS et al., 2009).

METHODOLOGY

The aim of this study was to develop a teacher training model using TPACK. Thus, the research had a quantitative approach in order to collect data that could meet the goal established in the study. The choice of the type of approach is justified as it was necessary to understand in a punctual and structured way the data collected through the collection instruments used in the process, making it possible to generalize results obtained with the teachers participating in the research.

The research was conducted between 2017-2019, and its participants were teachers selected from basic education schools of the state public network of Santa Catarina/Brazil, partners in the InTecEdu Program. Initially, to join a new partner institution in the InTecEdu Program, visits and meetings are initially held with the school managers for presentation of the program and counterparts of the same. In a second moment, a lecture presenting the program, its scope and resources is given to the teachers of the school. Once the presentation is made to the teachers, they are given time to demonstrate their interest in participating. The teacher's adhesion occurs with his participation in a semi-presential course, with 130 hours/class, named "Integration of digital technologies in basic education disciplines". Thus, the application of questionnaires and data collection occurred during the course and were applied online.

For data collection, two questionnaires named "Teacher Profile Questionnaire" and "TPACK Questionnaire", both applied online, were used. The teacher profile questionnaire", made by the InTecEdu Program, was composed of 20 questions that sought to characterize the profile of the teachers participating in the program. This questionnaire was applied in the initial meetings, in 2017, 2018 and 2019 during the initial training actions of the course "Integration of digital technologies in basic education disciplines". Annual course offers have been made and three of them are presented in this document.

The TPACK questionnaire aimed to investigate the perception of teachers regarding the integration of technology in their classes. Instruments for diagnosis, based on the TPACK model, have been much used and there is a great diversity of models. The TPACK questionnaire was made using the research entitled Survey of Teachers Knowledge of Teaching and Technology prepared by Schmidt et al. (2009) as reference, which is a research composed of 54 self-report items of teacher measurement concerning the teachers' perception of teaching and technology. The questionnaire was adapted and validated in the InTecEdu Program, containing 50 items (see Annex A) elaborated from a review of the model mentioned above and rewritten for the reality of this program. The 50 items were arranged on a five-point Likert scale, see Table 01, ranging from total disagreement (1) to total agreement (5), in order to evaluate the extent to which participants agree or disagree with statements about their beliefs about the relation between technology and teaching.

Table 1 - Scale of numerical values with scores.

Totally disagree (TD)	Partially disagree (PD)	No opinion (NO)	Partially agree (PA)	Totally Agree (TA)
1	2	3	4	5

Source: Prepared by the authors.

After application, the data obtained in the questionnaires were categorized according to the TPACK domains. Thus, the 50 items were distributed and categorized into the following subscales:

- Pedagogical Knowledge (PK), 9 items;
- Content Knowledge (CK), 5 items;
- Technology Knowledge (TK), 7 items;
- Pedagogical Content Knowledge (PCK), 7 items;
  Technological Content Knowledge (TCK), 6 items;
- Technological Pedagogical Knowledge (TPK), 8 items; and
- Technological Pedagogical Content Knowledge (TPACK), 8 items.

To estimate the reliability of the instruments, the Cronbach's Alpha coefficient was defined for the two questionnaires, although it is noteworthy the existence of different methods for obtaining the reliability index. According to O´Dwyer and Bernauer (2014), Cronbach's Alpha coefficient is widely used for Likert scales, being one of the most powerful. Besides being the most usual in the scope of research in Educational Technology (BARROSO; CABERO, 2013) and which offers more flexibility for several types of data that can be found (O´DWYER; BERNAUER, 2014). The Alpha coefficient measures the correlation between responses on a questionnaire by analyzing the profile of answers given by respondents. This is an average correlation between questions (HORA, MONTEIRO, ARICA, 2010). Cronbach's alpha coefficient is a commonly used reliability measure of (i.e., the evaluation of the internal consistency of the questionnaires) for a set of two or more construct indicators (BLAND, ALTMAN, 1997). Alpha values range from 0 to 1.0; the closer to 1, the greater the internal consistency of the analyzed items. The reliability of the scale should always be obtained with the data of each sample to ensure the reliable measurement of the construct in the concrete sample of investigation. As a general criterion, George and Mallery (2003) recommend the following indications for the evaluation of Cronbach's alpha coefficients.

Table 2 - Internal consistency of the questionnaire according to the alpha value.

Alpha coefficient value	Internal consistency
> 0.9	Excellent
> 0.8	Good
> 0.7	Acceptable
> 0.6	Questionable
> 0.5	Poor
<0.5	Unacceptable

Source: George and Mallery (2003).

The questionnaire for data collection on the TPACK model was applied at the end of the initial training actions carried out through the course "Integration of digital technologies in basic education disciplines", which took place in 2017, 2018 and 2019. The data obtained through the application of the questionnaires helped to specify the teachers' training needs. In this sense, specific training/improvement actions were developed for each target group. And finally, the articulation of technological resources with the conceptual experience of teachers and the needs identified in the disciplines the teachers taught, in view of the process of teaching the contents, with the construction of lesson plans that contemplated teaching strategies reinforced with technological resources. The building of lesson plans was inspired by the TPACK framework, which also included the maker workshops with the same previously participating teachers.

The initial contact was made with educational managers or teachers interested in participating in the training actions. The action following the meeting with the managers was to do a presentation, in person at the school, of the IntecEdu Program to all teachers interested in the theme. In this presentation, the goal was to describe the project, present the interests of the group involved in the research, as well as the role of the possible participants in the project. After this first contact with the teachers, the process of joining the teachers who will participate in the first training action, which is the semi-presential course, with 130 hours/class, named "Integration of digital technologies in basic education disciplines", begins.

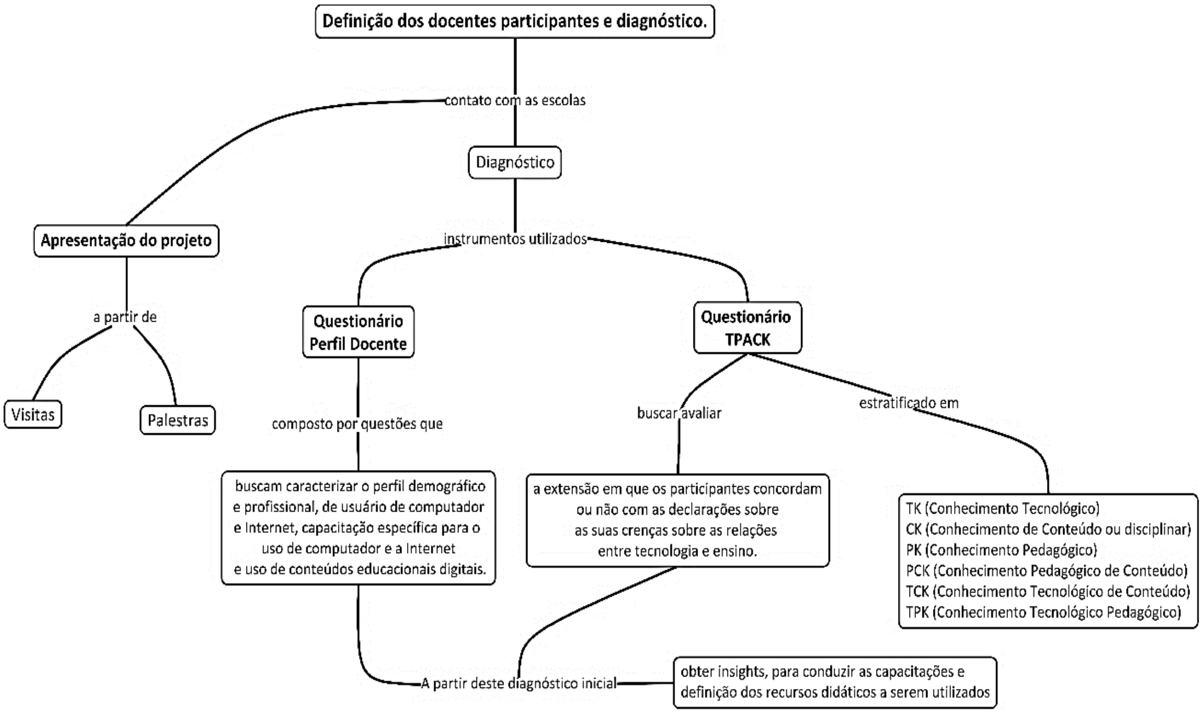

Figure 5 - Definition of teachers and diagnosis
Source: Prepared by the authors (2020).

The following actions of teachers' qualification had been preceded by initial diagnosis that sought to analyze their technological, pedagogical and discipline/content knowledge. To complement the data it was also necessary to understand how the teachers thought the integration of technology in his/her classrooms. From this initial diagnosis, data that helped to specify the teacher's training needs were obtained. In this sense, specific training/improvement actions were developed for each target group. They also made it possible to plan the conduct of specifications and requirements of the teaching resources that would be implemented and included in the lesson plans.

Thus, considering the diagnosis made initially, the model designed for the training of teachers to integrate technology in the lesson plans was developed, as shown in Figure 06.

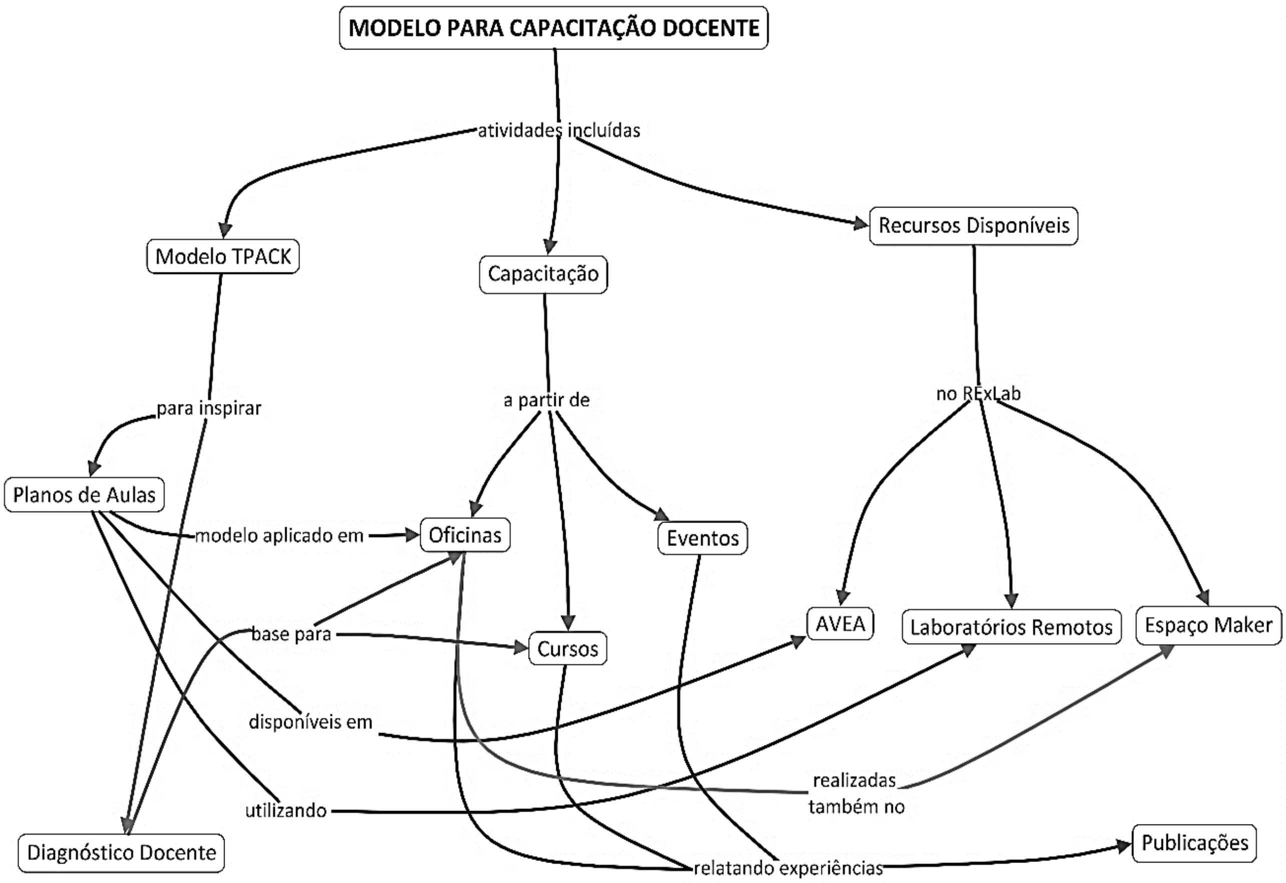

Figure 6 - Model overview.
Source: Prepared by the authors.

The model includes three large groups, considering the activities and resources necessary for the integration of technology in the lesson plans of the participating teachers. The so-called TPACK model is related to the initial diagnosis and the formal building of the lesson plans from a maker perspective. In this sense, the model sought to provide opportunities for teachers, who were the protagonists of the integration of technology in their lesson plans. Since they were in charge of building, producing and making available the digital content produced and other resources that supported their teaching activities to the students.

The second, named Capacity Building, is related to the activities that made construction possible and also aimed at giving visibility to the lesson plans built. The training of teachers had its formalization through online and semi-presential courses, online and classroom mini-courses, workshops and lectures that addressed themes and case studies regarding the integration of technology in education.

The third was associated with the provision of resources for the building of lesson plans. The main used resources were provided by RExLab through the virtual teaching and learning environment, the virtual and remote laboratories and the digital manufacturing and prototyping space (makerspace).

Therefore, the next step was to develop, in detail, the course of teacher training activities and provision of lesson plans, as shown in Figure 07.

Thus, once the participating teachers were defined, a 130-hour semi-presential course named "Integration of digital technologies in Basic Education subjects" started. For certification, teachers had to perform at least 75% of online activities, in addition to having digital content available at AVEA for at least one subject in the classes in which they taught.

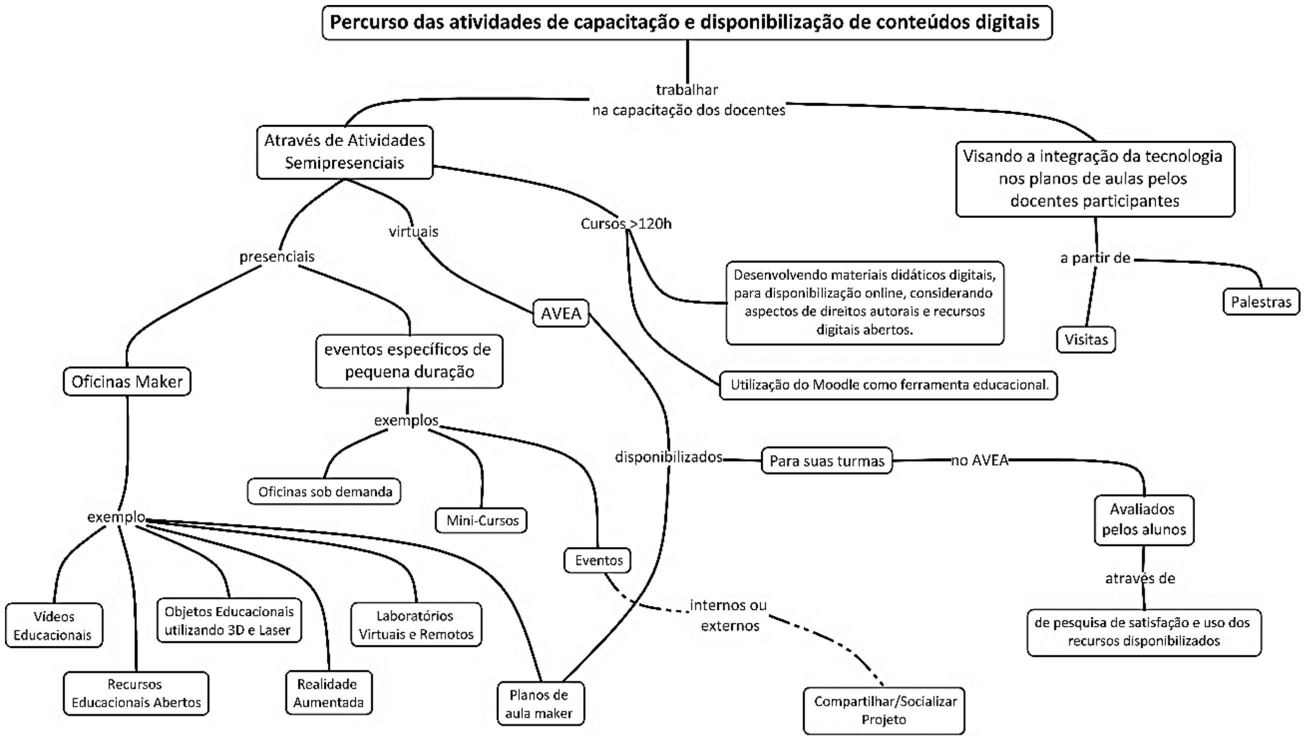

Figure 7 - Route of training activities and availability of digital content.
Source: Prepared by the authors.

After completing the initial training course, training/improvement actions were developed, more specifically maker workshops. Finally, the articulation of technological resources with the conceptual experience of teachers and the needs identified in the disciplines the teachers taught and which contemplated teaching strategies reinforced with technological resources. The building of lesson plans was inspired by the TPACK framework, as previously presented.

The training actions were expected to contribute to the training of teachers for an innovative use of technology by providing practical baggage that would allow them to direct and plan learning activities by integrating technology into the lesson plans. The developed model sought to fulfill three stages: technological appropriation, teaching strategies and articulation of technological resources with the conceptual experience of teachers and the needs identified in the disciplines conducted by them in the face of the process of content teaching.

The stage called “technological appropriation” covered three levels: access, adoption and appropriation of technology:

-Level of Access to Technology: teachers were able to identify their new educational context and sought to develop pedagogical and technological skills to be applied in new teaching strategies. In this sense, it was essential for teachers to acquire certain skills, knowledge and attitudes that enabled them to apply innovative strategies and models to integrate technology in the teaching and learning processes.

-Technical Adoption Level: after identifying a new working method with the support of technology, the teachers then started using the technologies in their lesson plans.

-Level of Technology Appropriation: teachers assumed the integration of technology in their lesson plans. It is not a definitive attitude, as it is subject to progressive reinforcement.

The last phase referred to the articulation of technological resources with the conceptual experience of teachers and the needs identified in the disciplines conducted by teachers in the face of the process of teaching the contents. In this phase, teachers were motivated to fundamentally consider the building of lesson plans contemplating pedagogical strategies reinforced with technological resources. The building and application of lesson plans inspired by the TPACK framework was the result obtained in this phase.

RESULTS AND DISCUSSION

The teacher training model of the InTecEdu Program was developed inspired by TPACK and applied and evaluated with the teachers who were selected after visits and presentation of the program to interested schools. In its first stage, the model includes a semi-presential course, with 130 hours/class, named "Integration of digital technologies in Basic Education subjects". In this course, teachers needed to complete at least 75% of online activities and make digital content available in the AVEA of the InTecEdu Program, in at least one discipline they taught. Regarding the distribution of the workload, 90 hours/class are completed in the AVEA and 40 hours/class in classroom activities, which are formalized through face-to-face workshops on specific topics, for example, building of learning objects in RExLab maker space, use and prospecting of specific digital resources for educational use. Teachers who meet the course completion requirements receive an extension course certificate from the Federal University of Santa Catarina.

This survey presents data from three editions of the course held annually, in the period 2017-2019. 398 (45.02%) out of a total of 884 teachers assigned to participating partner schools completed the initial training course. Namely five public schools in the state of Santa Catarina.

For initial diagnosis purposes, online questionnaires were applied, available at AVEA where the initial training course was available. There were two questionnaires, being one named "Teacher Profile", which sought to characterize the profile of teachers, and the second one named "TPACK Questionnaire", sought to explore the perception of teachers related to their knowledge: technological, pedagogical and disciplinary/content, and how they integrate technology in their classrooms. In other words, to know the degree of training and use of ICT in class by the teachers. From the initial diagnosis, some data were obtained to conduct the specifications and requirements of the teaching resources that were implemented in the lesson plans.

The data obtained from the questionnaires applied to teachers helped to specify their training needs. Furthermore, specific training/improvement actions were developed for each target group. And finally, the articulation of technological resources with the conceptual experience of teachers and the needs identified in the disciplines the teachers taught, in view of the process of teaching the contents, with the construction of lesson plans that contemplated teaching strategies reinforced with technological resources. The building of lesson plans was inspired by the TPACK framework and the teachers were given a classroom workshop related to the preparation of the lesson plan, from the perspective of the framework used and inspired by the maker culture. The lesson plans prepared in face-to-face workshops were used to make digital content available in the AVEA of InTecEdu Program for students of the participating teachers.

Next, some data from the two questionnaires are presented and discussed. For that, 362 (90.9%) of the participating teachers answered the "Teacher Profile" questionnaire, being 81.85% women and 18.15% men. Figure 08 shows the distribution by age group. The highest percentage is concentrated in the age group of 36 to 40 years old (22.13%), while 46.12% is older and 53.88% is younger than 40 years old, with 19.25 being younger than 30 years old .

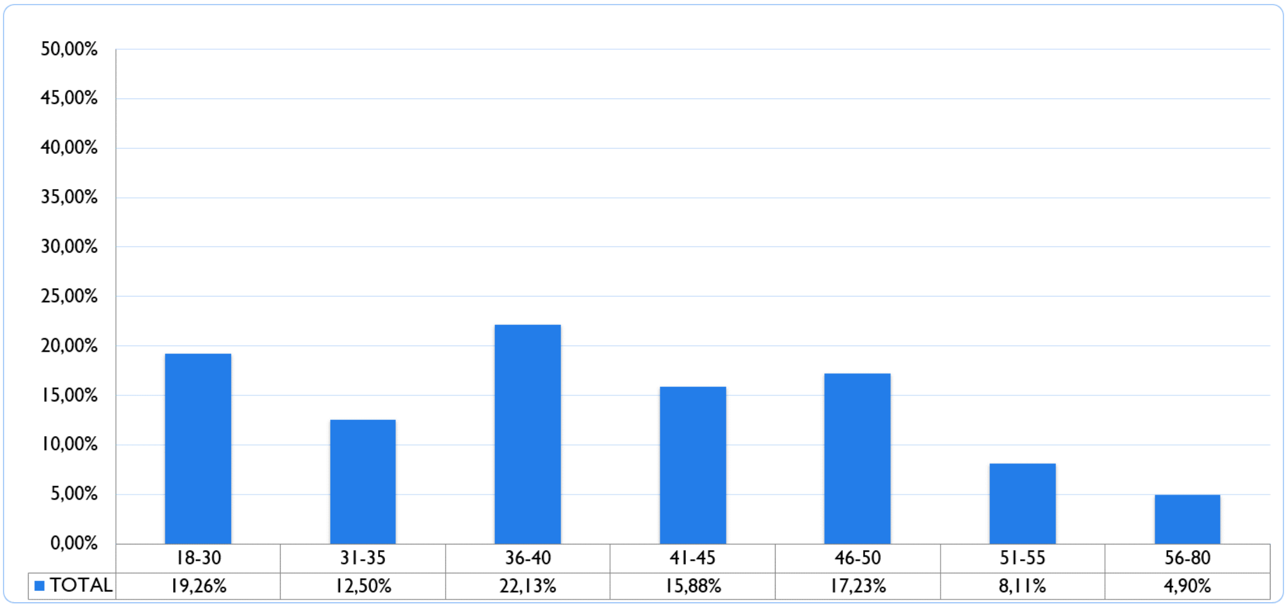

Figure 8 - Distribution by age group
Source: Prepared by the authors (2020).

Figure 09 shows the distribution of teachers in relation to their experience as teachers in Basic Education. A balance is noticed between the ranges proposed in the graph. Being that 20.44% of the teachers have 20 years and 79.56% have up to 20 years of experience in teaching. Of these, 39.02% have up to 10 years, 22.13% have less than 5 years of experience in teaching.

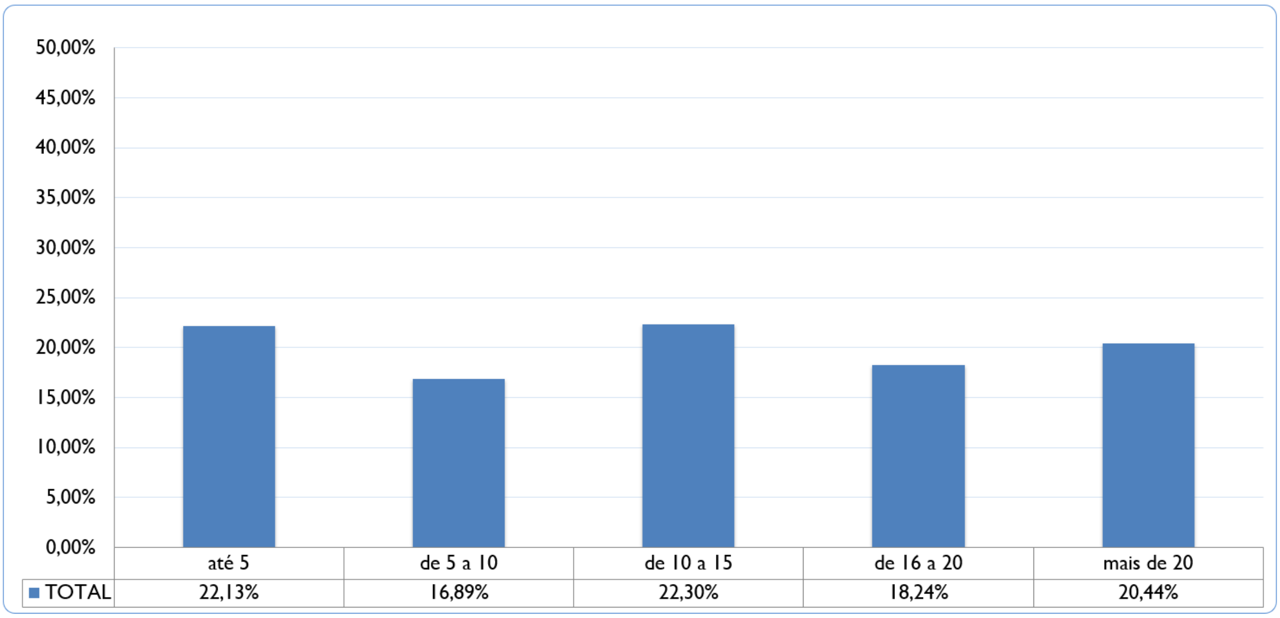

Figure 9 - Time of teaching experience.
Source: Prepared by the authors (2020).

Regarding formation, 96.33% said they had attended higher education (66.06% degree courses, 19.27% pedagogy). Regarding postgraduate studies, 81.15% attended a specialization level, 2.08% a master's degree and 16.77% did not. As for the administrative dependence of the schools they worked in: 63.77% in state, 32.26% in municipal and 4.30% in the federal networks, being 59.76% effective/tendered employees and 40.24% having temporary contracts . As for the exercise of professional activity, 64.88% declare to work in one school, 60.65% in two and 4.46% in three or more.

Regarding the number of weekly hours dedicated to classes, the data show more than 40 hours, as shown in Figure 10.

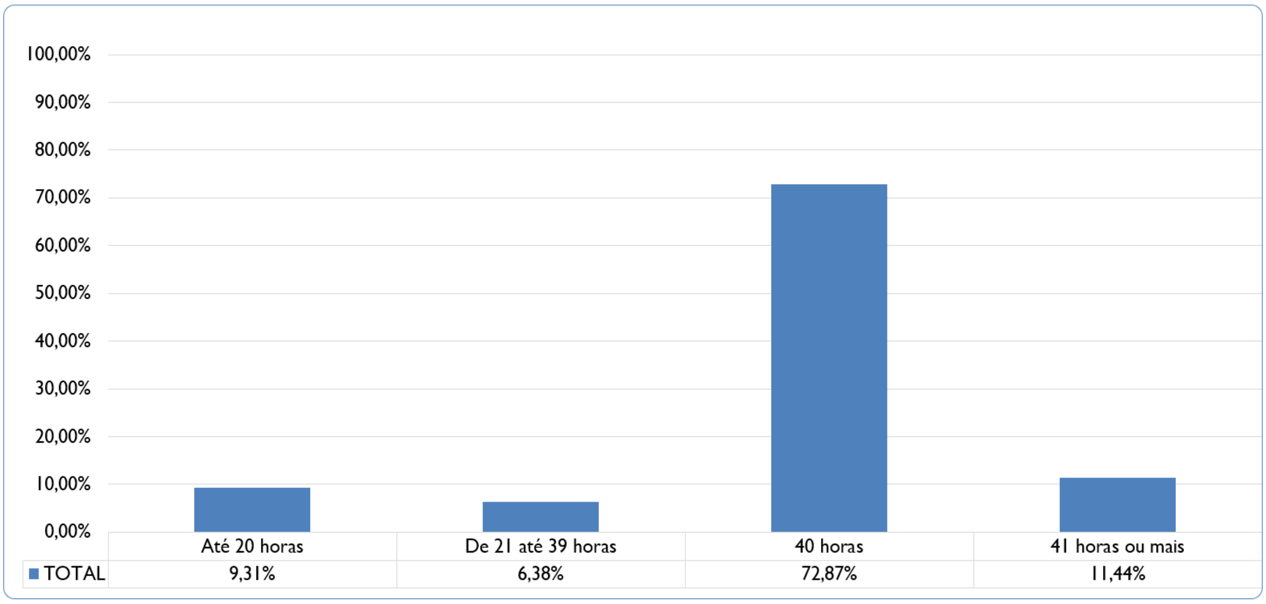

Figure 10 - Weekly hours dedicated to classes.
Source: Prepared by the authors (2020).

Regarding technology, only 1.69% declared they did not have a microcomputer and 60.28% had a laptop. Regarding the way one learned to use the computer and the Internet, 33.67% answered “alone” and 21.09% took a specific course.

The data collected in relation to some statements obtained the following:

“The students at this school know more about computers and Internet than the teacher. You?”, 92.59% of the teachers indicated“ I totally agree ”(27.95%) and“ I partially agree ”(64.65%);

“I believe more in traditional teaching methods. You? ”, 43.54% of the teachers indicated“ I totally agree ”(0.68%) and“ I partially agree ”(42.86%);

“You don't know how or for which activities you can use computers or the Internet at school. You? ”, 35.75% of the teachers answered "I totally agree ”(13.61%), “I partially agree ”(22.21%) and 60.20% of the teachers answered“ I totally disagree ”(37.71%) and “partly disagree” (24.49%);

“Lack of pedagogical support for the use of computers and the Internet. You?" 76.87% of the teachers answered “I totally agree” (43.20%) and “I partially agree” (33.67%);

“Lack of pedagogical support for the use of computers and the Internet. You? ”, 76.87% of the professors indicated“ I totally agree ”(43.20%) and“ I partially agree ”(33.67%);

“Teachers do not have enough time to prepare classes with computer and Internet. You? ”, 70.41% of the teachers answered“ I totally agree”(34.35%) and“ I partially agree ”(36.05%);

The TPACK questionnaire was applied at the end of the initial training actions carried out through the course “Integration of digital technologies in Basic Education subjects”, which took place in 2017, 2018 and 2019. The “TPACK Questionnaire” was answered by 361 (90.7%) of the teachers who took the initial training course. The data acquired in the questionnaire were grouped considering the seven domains of the TPACK and, according to the Likert Scale, the scores for each one were aligned. A Cronbach's alpha coefficient of 0.91 was found for the applied questionnaire in its total (50 items). which is considered “excellent”, according to the general evaluation criteria recommended by George and Mallery (2003). The average score on the Likert scale for the 50 items in the questionnaire was 3.65, on a scale of 1 to 5, where 1 represented “Totally Disagree” and 5 “Totally Agree”. The standard deviation found for the items mean was 0.36 and the Coefficient of Variation was 9.88%, which is considered low and indicates a homogeneous data set. The values of the mean scores on the Likert scale applied to the domains and subdomains of the TPACK are shown in Figure 11.

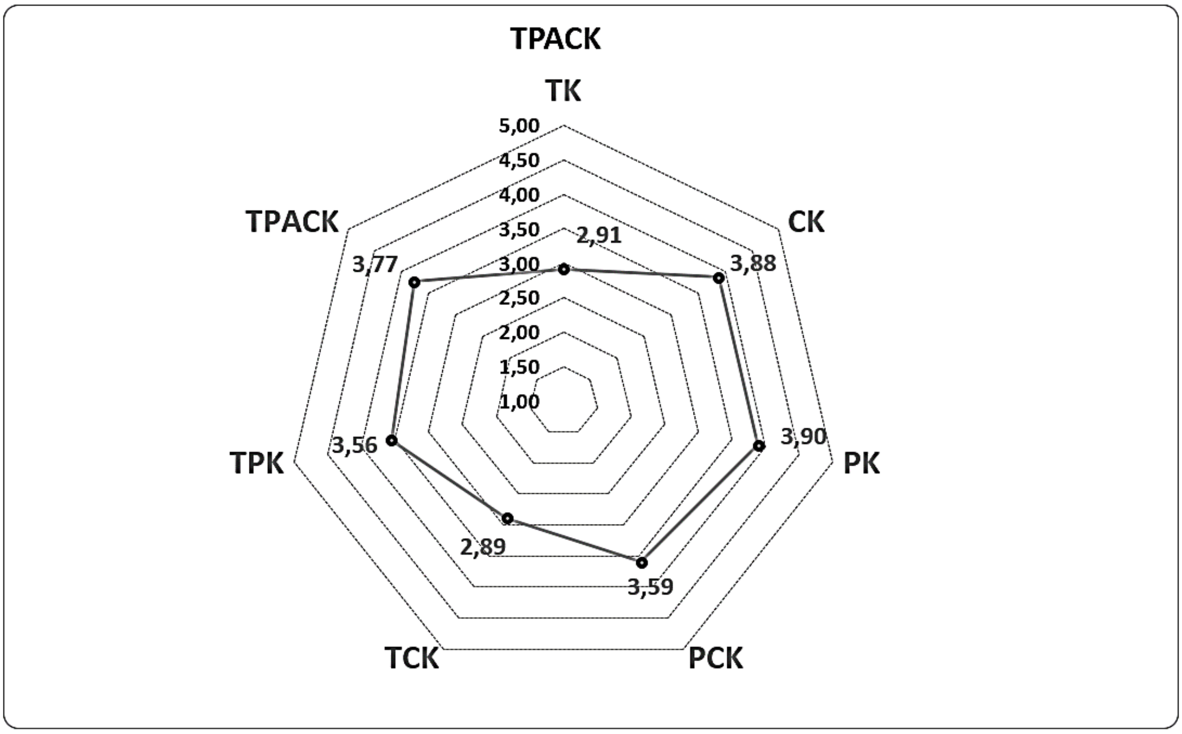

Figure 11 - Average scores on the Likert scale for TPACK domains and subdomains.
Source: Prepared by the authors (2020).

Based on Mishra and Koehler (2006), for a better understanding of TPACK, it is necessary, initially, to understand the three components that make it up: Pedagogical Knowledge (PK), Content or Disciplinary Knowledge (CK) and Technological Knowledge (TK) and subsequently their relations. PK is the general knowledge and teaching-related skills and includes knowledge of general teaching methods. This is related to the understanding of educational theories of teaching and learning, that is, "the knowledge that is involved in all issues related to student learning, classroom management, development and implementation of lesson plans and student evaluation" (MISHA; KOEHLER, 2006). The average score on the five-point Likert scale (1 to 5) applied for the seven items of the PK subscale, was 3.90. The Cronbach's alpha coefficient calculated for the subscale (7 items) was 0.79, the standard deviation for the items mean was 0.18 and the Coefficient of Variation was 4.31%. In percentages, the mean value for PK was 83.10%, which is the sum of the answers "partially agree" (73.7%) and "totally agree" (9.4%).

CK is the knowledge of the acts, concepts and knowledge that exist in a particular domain, for example, they are the contents that should be learned in Physics classes in the second year of High School. CK is the knowledge of the subject to be treated in class, whose level of deepening differs according to the education level, for example, the difference in the content of Thermodynamics addressed in high school in relation to higher education. Thus, the teacher must understand the theory and the organization of its development (SHULMAN, 1986).

The mean score on the Likert scale for the seven items of CK composition was 3.88. The Cronbach's alpha coefficient calculated for the subscale (7 items) was 0.80, the standard deviation for the items' mean was 0.11 and the Coefficient of Variation was 2.93%. In percentages, the average value for the CK was 81.4%, which is the sum of the answers "partially agree" (59.6%) and "totally agree" (21.9%).

TK, on the other hand, is a necessary knowledge to understand and use different technologies. This knowledge is linked to the understanding of technological devices, their purpose, functionality, handling, among others. Technological knowledge is constantly changing due to the continuous improvement of technologies and includes the ability to learn and adapt to a new technology. This technological context covers ICT, general purpose software, the Internet and related technologies, such as educational software, simulations, modeling tools, remote experimentation and much more (KOEHLER; MISHRA, 2008). The mean score on the Likert scale for the seven items of TK composition was 2.91. The Cronbach's alpha coefficient calculated for the subscale (7 items) was 0.76, the standard deviation for the items' mean was 0.47 and the Coefficient of Variation was 16.16%. In percentages the mean value for the TK was 37.6%, considering the sum of the answers “partially agree” (33.9%) and “totally agree” (3.6%).

The TPACK model proposes the interaction between the three types of knowledge which makes up its core and the constituent elements of current learning environments. To seek this interaction, the TPACK model needs to go beyond an isolated view of the three types of knowledge it composes, being necessary to emphasize the connections and the complex relationships between the three dimensions of knowledge (its constituent elements). These are: Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK) and Pedagogical Technological Knowledge (PTK).

PCK considers Pedagogy (P) and content (C) together to provide Pedagogical Content Content, that is, the ability to teach a certain curriculum content. According to Shulman (1986), the PCK represents the pedagogy knowledge that is applicable to the content instruction of a specific science. For Mishra and Koehler (2006), the idea of pedagogical knowledge of the content is applicable to the teaching of a specific content. PCK includes knowing how the elements of the content can be organized to improve teaching. This knowledge is different from that of the specialist in the content and also of the pedagogical knowledge that is shared by teachers from different disciplines. Thus, PCK is aimed at the representation and formulation of concepts, pedagogical techniques, knowledge of what makes it difficult or easy to learn certain concepts, knowledge of students' alternative conceptions and theories of. The mean score on the Likert scale for the seven items of composition of PCK was 3.45. The Cronbach's alpha coefficient calculated for the subscale (7 items) was 0.69, the standard deviation for the items' mean was 0.48 and the Coefficient of Variation was 13.98%. In percentages, the mean value for PCK was 62.0% considering the sum of the responses “partially agree” (57.6%) and “totally agree” (4.4%).

Technological Content Knowledge (TCK) is the mutual relationship between content (C) and technology (T) and is built from the integration of Technological Knowledge (TK) and Content Knowledge (CK), that is, knowing how to select the most appropriate technological resources to communicate a certain curriculum content. This type of knowledge is useful to describe the knowledge of a teacher and how the didactic content of a discipline can be transformed through the application of a technology. A good example of this type of knowledge are computer simulations of physical phenomena illustrating the contents to which they relate. The mean score on the Likert scale, for the seven items of TCK's composition was 2.79. The Cronbach's alpha coefficient calculated for the subscale (7 items) was 0.86, the standard deviation for items' mean was 0.35 and the Coefficient of Variation was 12.56%. In percentages, the mean value for the TCK was 36.0%, considering the sum of the answers “partially agree” (24.7%) and “totally agree” (3.3%).

Technological Pedagogical Knowledge (TPK) refers to general understanding of the application of technology in education without making reference to a specific content, that is, knowing how to use these resources in the teaching and learning process. TPK includes knowledge of how technology can support specific pedagogical strategies and/or goals in class. A good example is the use of forums and social networking sites for educational purposes, which were not initially created for this purpose. The mean score for the eight items of the TPK on the Likert scale was 3.56. The Cronbach's alpha coefficient calculated for the subscale (8 items) was 0.74, the standard deviation for the items' mean was 0.27 and the Coefficient of Variation was 7.39%. In percentages the mean value for the TPK was 79.8% considering the sum of the answers “partially agree” (76.2%) and “totally agree” (3.6%).

Finally, considering the three new types created together (PCK, TCK and TPK), there is the Technological Pedagogical Content Knowledge (TPACK). Koehler and Mishra (2006) maintain that the true integration of technology requires an understanding and negotiation of the relations between these three components of knowledge.

The mean score for the seven items that make up the TPACK on the Likert scale was 3.77. The Cronbach's alpha coefficient calculated for the subscale (7 items) was 0.73, the standard deviation for the items' mean was 0.28 and the Coefficient of Variation was 7.65%. In percentages the mean value for the TPACK was 78.7%, considering the sum of the answers “partially agree” (65.5%) and “totally agree” (6.6%). Effective and efficient teaching is not simply adding technology and mastery of existing content in the classroom, however, the introduction of technology may enable new representations of concepts (KOEHLER, MISHRA, 2007; SCHMIDT, SAHIN, THOMPSON, SEYMOUR, 2008; SCHMIDT, BARAN, THOMPSON, MISHRA, KOEHLER, SHIN, 2009).

Among the 398 teachers who completed the course, 67 (16.84%) continued to use the resources in their classes, as pointed out by the participants in the applied questionnaire. These teachers produced and made available didactic content in the AVEA of the InTecEdu Program for 224 classes with the assistance of 6,570 students. This number reached 61.64% of the total enrolled students (10,659) in elementary and high school, in participating schools. These data were collected at AVEA, since both the training course and the classes made available by teachers are in the virtual environment of the program.

Regarding the integration of technology in the STEM areas, 29 teachers, 67.44% of the identified teachers working in the area made their didactic content available. The contents served 3,360 students, from 98 classes from 9 schools. These students had access to Virtual and Remote Laboratories in lesson plans in the disciplines of Physics and Biology (High School), Science (Elementary School), among other resources. To support practical activities in the STEM areas, 20 remote laboratories, with 26 instances, were made available for use in practical activities in disciplines [http://relle.ufsc.br/labs].

Therefore, considering the data collected, an adequate teacher training for the new reality of society and the contribution of the TPACK model for pedagogical practices supported by ICT is necessary. The data collected allowed us to understand a little more about the teachers who are working in the state schools of Santa Catarina, as well as the challenges of including technological resources in the Basic Education classroom.

FINAL CONSIDERATIONS

Society is being technologically transformed and this process is reflected in schools. Thus, it is increasingly necessary to consider new methodologies and pedagogical strategies that may include technologies in pedagogical practices. However, although there is this need, there is little use of technological resources in the classroom, raising many questions about the reasons for it.

In this context, the present study understood the needs of students and teachers' demands regarding the use of ICT in the classroom. This paper aimed to present and evaluate a model of teacher training for the use of ICT in the classroom using the TPACK for such. In this sense, a survey on the teacher training model applied during the process of this research, as well as on the view of teachers who participated in the research on the use of technologies.

The data collected in the diagnosis indicated that teachers know how to handle and understand how to use technologies in the classroom. However, there are still doubts about the most effective methods for teaching. This type of data points to a lag regarding the demands that students bring to the classroom and what teachers consider most pertinent. It is worth mentioning that the teachers' answers correspond to a context with different elements that can influence the notes, and it is pertinent to deepen on this theme, in a future study.

In relation to the TPACK model, teachers still struggle with its use in the classroom, although they initially answered they had knowledge of how and when to apply them. Thus, the training model proposed in the research proved to be efficient, since it allowed teachers not only to learn how to use technologies in the classroom, but also to reflect on their own pedagogical practices. The use of TPACK in the classroom was evident by the data on the use of ICT after the research, although small, but relevant to point out changes initiated in the teaching and learning process

This study may help understanding there is still much to investigate on the subject and teachers increasingly need teacher training so that they can understand and distinguish the most pertinent models, that encompass or not the precepts of the new connected and technological society.

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