

# Permanent Education and the Integration of Digital Information and Communication Technology in Physics Education in Santa Catarina

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## Abstract

Educating Physics teachers has shown to be a great challenge. The present work is part of a bigger study that has had as its central axis two demands related to the education of these professionals: the first one refers to social changes brought about by the Digital Information and Communication Technologies (DICT), which require a (re)signification of the school and of the teacher's profile; and the second relates to the great percentage of teachers working in the field without the qualifications that the profession requires. The focus here will be the process of integrating the DICT in the practices of the Physics teachers who participated in a continuing education course that was planned and developed during the research. It can be inferred that the development of the activities and discussions about the pedagogical practices conducted during the course resulted in the comprehension around the critical and creative use of the DICT. However, it is important to keep in mind that such an integration constitutes a slow and gradual process.

## Keywords

Permanent Education, Physics teachers, Physics Teaching, Digital Information and Communication Technologies, Knowledge sharing, Distance and in-person practices.

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## Introduction

Teacher education, whether initial or continuing, has been a permanent challenge in all educational levels. In the specific case of Physics teachers, the largest problem lies in the shortage

### State of the literature

- Teacher education, both initial and continuing, remains a great challenge, especially when one looks at Physics teachers, who, here in Brazil, add up to a great percentage, working in a classroom without having the proper preparation/education.
- The discussions around the education of Physics teachers for the critical integration of Digital Information Technologies in the teaching of Physics is still nascent in Brazil.
- The creation of virtual practice communities with Physics teachers is an issue that needs further study.

### Contribution of this paper to the literature

- This article contributes to research regarding the continuing education of Physics teachers by presenting a course proposal, which can be used in different contexts.
- We present the creation of a virtual practice community as a good strategy for removing the teacher from isolation, for promoting interactions among teachers as well as the sharing of knowledge and practices.
- We defend that a critical integration as submitted in this article constitutes a slow and gradual process, which requires/requiring an adequate structure in terms of available technologies, technical support and time for the planning of activities.

of qualified in-service professionals. This paper is part of doctoral research that had as its central axis two demands surrounding the education of these professionals: the first refers to the social changes brought about by Digital Information and Communications Technologies (DICT), which vindicate a (re)signification of the school and the teacher's profile; and the second speaks to the high percentage of teachers working without having the adequate qualification for the profession. The objective was to develop and evaluate a proposal for continuing education, as well as its contributions to teacher education and to the teaching of Physics in the schools within the Santa Catarina (SC) state-level public school network. The investigation's central question was essentially concerned with understanding what contributions the proposal in question can offer towards meeting the demands present in the teachers' education and practice in the context of the Santa Catarina public state schools.

This investigation had a qualitative nature, constituted by action research, which immersed its participants in a continuous process of reflection and action. In view of responding this question, a continuing education course was organized around the proposal of the Three Pedagogical Moments. (Angotti, 1982, 1991; Delizoicov, 1980, 1982, 1991, 2004; Delizoicov & Angotti, 1994), also inspired on Paulo Freire's pedagogy, as a means of guiding the organization of the continuing education course and contributing to the analyses throughout the research. The *First Moment – Initial Problematicization* propitiates a critical distancing from the student. The teacher, by confronting the interpretations of the situations proposed for discussion, allows for the recognition of the need to obtain new knowledge with which the situation can be more adequately interpreted. During this moment, issues and situations related to the subject to be addressed and

that, at the same time, have the potential to be problematized, are brought up. The *Second Moment – Organization of Knowledge* involves the systematic study of the knowledge necessary for understanding the subject at hand and for unfolding solutions to the issues raised in the Initial Problematization. This is the phase in which new knowledge is developed for the student, in this case, the teacher participating in the course. The content is programmed and prepared in instructional terms in order for the teacher to be able to: first, apprehend it in such a way so as to discern the existence of other visions and explanations regarding the situations and phenomena that are being problematized; and second, compare this new knowledge to that which he or she possesses, in order to utilize it to better interpret those situations and phenomena. The *Third Moment – Application of Knowledge* affords the student the opportunity to utilize the knowledge that was built to interpret the situations that were problematized initially, in an effort to circumscribe the level of knowledge reached. It is this phase in which the teacher verifies what was learned, and new situations are explored, preferably linked to the teacher's day-to-day experiences. The objective is to allow for these to be understood and explained using the body of knowledge developed in the second moment. It sought the teacher's personal and professional growth and the demand of a continuing and in-service education, pointing towards the creation of a virtual community of practice (VCP) conducive to knowledge-sharing around the teaching of Physics and to the constitution of a network of Physics teachers.

Instruments for data collection included questionnaires given to the teacher-participants of the continuing education course, activities developed throughout the course and records kept of the in-person sessions, of the online interaction and moments of reflection, in addition to an online questionnaire sent to all Physics teachers in the SC public school network. The research was grounded in three dimensions. The epistemological dimension, based on the ideas of Fleck (2010), mainly the notions of thought-collective and thought-styles, circulations and complications. The perception and confrontation of complications are brought into focus as the awareness of a problem that is still unresolved and/or “associated with limitations of the thought style when confronting a particular problem” (Gonçalves, Marques, & Delizoicov, 2007, our emphasis). The objective is to enlarge and/or transform *Thought Styles*, and to form a network of teachers that will allow them to come out of isolation. We believe that interaction of teachers from different realities, with other experiences, from different collectives, will allow for a re-reading of the practice, the perception of exceptions or complications, and the establishment, extension, or transformation of thought styles. According to Fleck, a thought style must be altered for the discovery of something new to be made possible. “No new proposition can be constructed merely through passive coupling. There is always a presence of something active, or, using a less indicated term, something subjective” (Fleck, 2010, p. 93).

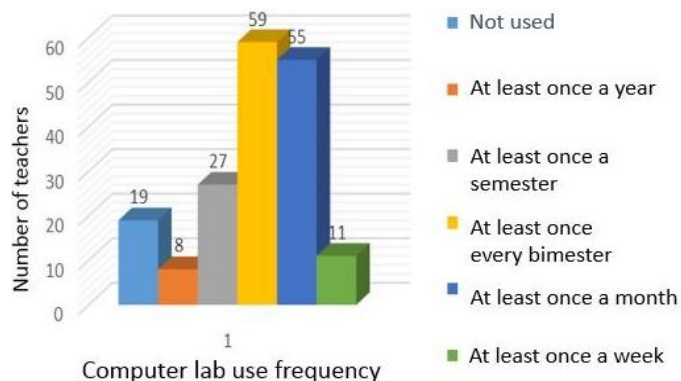
The didactic-methodological dimension, sustained by Freire's (1977, 2011a, 2011b) ideas, especially in regard to the categories of dialogicality and problematization. We perceive dialogicality as a path for structuring the possibilities around knowledge production and

construction, once dialogue as a practice provides the sharing of realities experienced by the participants. Problematization would be a manner of bringing in the different world views of those partaking in the dialogue, thus revealing the participants' knowledge, permeating communication, having been constituted by particular stories and experiences. Finally, the technological dimension, based on the perspective of education media (Bévort & Belloni, 2009; Fantin & Rivoltella, 2012) and Mishra and Khoeler's (2006) Technological Pedagogical Content Knowledge (TPACK). Its fundamental premise holds that the ideal combination for integrating DICT into the curriculum is a result of the balanced mixture of scientific knowledge or of pedagogical and technological content (Espindola, 2010; Sampaio; Coutinho, 2012). It is a framework that connects technology to the curriculum and describes the manner in which teachers understand the three basic forms of knowledge that interact with one another so as to develop disciplinary pedagogical approaches using educative technologies (Coutinho, 2011). This theoretical framework is, thus, consistent with the objectives of this research, especially with regard to re-thinking teacher education, and to basing the analyses of the research that approaches the technological universe within education. These dimensions were used in the organization and development of the course, as well as for its analysis. The focus of this paper will be on the integration of the DICT within the practices of the teacher-participants, as well as the potential of these technologies for the ongoing permanent education process.

### About the Permanent Education Course

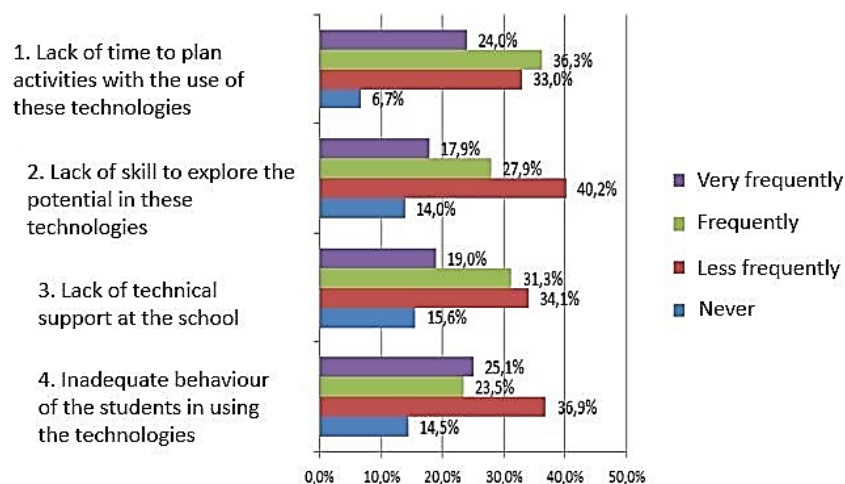
In order to contribute towards the education of Physics teachers in state-level schools in Santa Catarina, we have structured a course proposal from our experience with the teaching of Physics and the education of teachers in this subject, taking into consideration the demands perceived by them in the practice of the profession and underscored by researchers in this area. Our goal for the course was to promote the construction of reflexive and investigative attitudes, elements indispensable for the performance of the physicist-educator, having the perception and confrontation of complications present in the reality of the school and specifically in the teaching-learning process of Physics as a starting point (Leonel, 2015; Leonel & Angotti, 2016). In this manner, we planned a continuing education course, called “Teaching Physics: A New Glance over the Practice,” in line with “Training System for Educators of the State Teaching Network”.

With the purpose of contributing with the planning and development of the continuing education course, we elaborated an online questionnaire with questions regarding teacher education and the use of technology by Physics teachers. The questionnaire was sent to Physics teachers of the state-level public school network who had registered an e-mail address with the Secretary of Education. The main objective of this questionnaire was to diagnose the education of teachers and the employment of the DICT. We counted with the participation of 179 teachers. **Figure 1** below shows the frequency with which these teachers use the school's computer laboratory.



**Figure 1.** Relative to the frequency of the employment of the computer lab by Physics teachers in the state-level public school network in Santa Catarina. (Source: The authors.)

The difficulties found regarding the use of DICT are presented in **Figure 2**, with a differentiation in frequency for each shown.

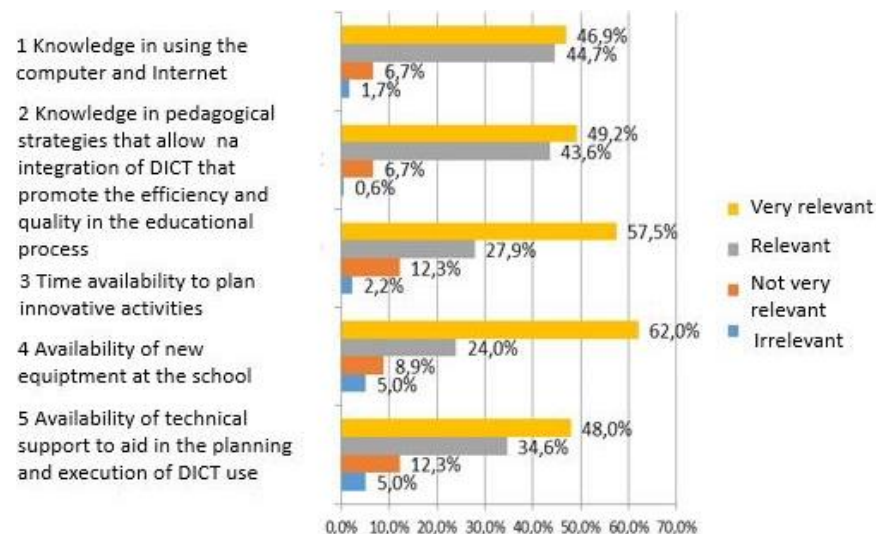


**Figure 2.** Relative to difficulties found by physics teachers in DICT use. (Source: The authors.)

As can be seen in Figure 2, the most frequent difficulty is the lack of time to plan activities that employ DICT, followed by the lack of technical support in regard to the development of such activities at the school. The third most frequent difficulty is the inappropriate behavior of students in the use of these technologies. In addition, the fourth is the lack of abilities needed to explore the potential of these technologies. The first and second difficulties can be characterized for going beyond teacher education, for they depend on a good structure, with good and periodic

technical support, as well as on greater time availability (an increase of productive time) to plan said activities. However, the third and fourth difficulties can be overcome through continuing education that contributes to the dominion of the necessary abilities for exploring the potential of the DICT and with an integration in line with the perspective of education media in Bévort and Belloni (2009), including a search for strategies that promote greater participation and involvement of students in regard to the employment of these technologies.

To exercise teaching with DICT, the teachers attributed the degrees of relevance presented in **Figure 3**, in accordance with the factors brought in the questionnaire: **Figure 3** shows us that teachers attribute great relevance to the availability of good equipment and technical support at the school to aid in the planning and execution of activities that employ DICT, of time for planning activities that use DICT and the need to have knowledge of pedagogical strategies that permit the integration of these technologies to promote efficiency and quality in the educative process. In addition, the relevance of technical knowledge necessary for the use of these resources cannot be undervalued.



**Figure 3.** Relative to knowledge considered to be necessary by Physics teachers for employing DICT. (Source: The authors.)

Parting from these issues, we elaborated a blended course, a modality known internationally as Blended-Learning or simply as b-Learning, and had 48 hours of in-class learning and 52 hours of distance learning, adding up to a total of 100 hours. There were six monthly in-class meetings, of eight hours each, which were held at the computer lab in the Center for Distance Learning (CDL) of the State University of Santa Catarina (SUSC). On the other hand, the distance classes and interactions occurred primarily in the room organized in the Moodle platform. However, as the

DICT were introduced, they also came to serve to promote and maintain the distance interactions. During the in-class meetings and in the distance interactions, the mediations always endeavored to contribute towards the perception and confrontation of complications present in the day-to-day of school life with the aim of developing critical thinking around the use of the different resources, such as experimental apparatus, different styles of language and DICT. Such actions promoted the gradual conscious acquisition of these resources, having as the horizon the planning of didactic-methodological strategies, which contribute towards the confrontation of problems raised by the teachers in the beginning of the course and in the interactions that followed. The DICT that were used were selected based on the demands brought forth by the teachers in the first in-class interaction, so that the objective of the course could be met, having, however, its usability by teachers with their students as the main criteria. Thus, as they learned to utilize them, reflections were provoked in the sense of contemplating digital inclusion as well as a glance towards the DICT as an object of study and pedagogical tool, the three dimensions raised by Bévort and Belloni (2009), as necessary for education in the perspective of education media. A few free applications were selected, in addition to simulations and social media, which could be used by the teachers in their practice. In the proportion that they became familiar with and explored these resources (collaborative writing, blog, Laifi, Youtube, among others), they interacted within and through the resource at hand, already contemplating different possibilities of how to integrate them in activities with their students.

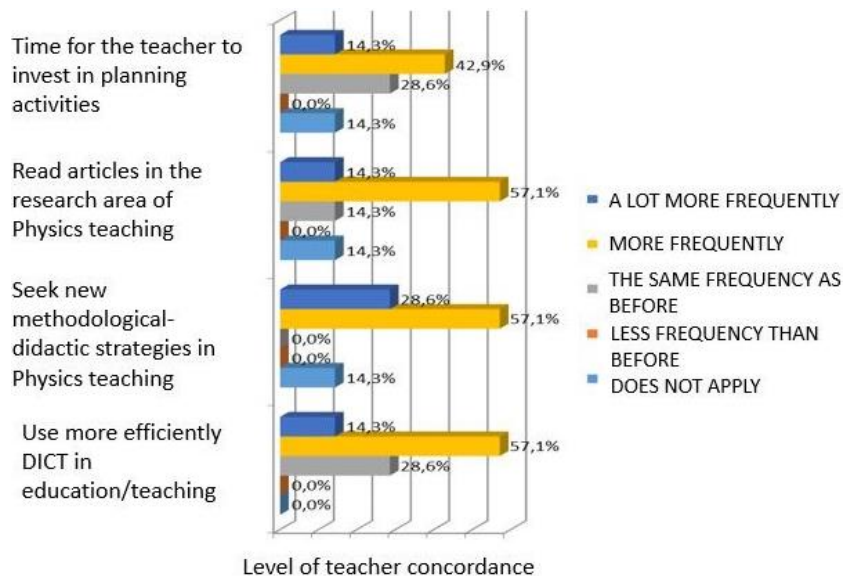
### The Integration of DICT in the Teaching of Physics

The course had ten teachers, but only eight concluded it. Before participating in the course, only two, among the eight teachers who concluded the course, made no previous use of DICT in the teaching of Physics. Among the six who had some previous experience, four recognized that the potential of the DICT had not been explored in favor of the construction of knowledge, but only to give a "feeling of modernity" in the classroom and grasp the attention of the students. All suspected that the DICT could contribute towards the teaching-learning process and that, for this, time for planning and skills in using these technologies were needed. For teachers P.03, P.05 and P.06, the lack of skills was the greatest obstacle for the use of DICT in their Physics classes. However, for P.08, P.09 as well as for P.05, the biggest problem was to be found in the lack of appropriate resources for the use of the DICT in the Physics classes. For P.08, the awakening to the use of DICT promoted a better use of class time and a breaking of barriers that many times separate teachers and students. Teacher P.05 did not care for DICT before the course, "but now I notice its importance for interacting with students in the exchange of information and also to aid in the educational process". And P.06 felt encouraged to innovate in his/her activities: "Making use of DICT to communicate with the students that was interesting and productive. I wouldn't have had the courage to ask them to complete an assignment only through the distance module had it not been for the course." In every moment, we strove for critical training in theory concerning pedagogical practices by teachers in the school, in a spiral: observation, action, and reflection, which serves for re-thinking practice and seeking new paths, as defended by the authors of research-action. In this perspective, the research sought to integrate theory production and the practice of teaching into a single process (Lisita, Rosa, & Lipovetsky, 2001). In the

practical sphere, we argue that, with the experience of incorporating DICT into teaching, teachers who take research into their practice are led to perceive, with greater ease, the potential of DICT in an emancipatory and transformative education. From the first moment, the teachers were invited to look at their context, starting at the problematized issues and with the intention of practicing, throughout the course, the spiral exercise: observation, reflection, and action, characteristic of investigation-action, and necessary for a reflective teacher. It was from this perspective that, throughout the second moment, each teacher chose an issue to study more closely and to have as a basis for carrying out the planning and research conducted throughout the course, especially in the third moment. This is after they had gone through collective and individual moments of observation and reflection, by raising questions about the context of each one's activity, and included observation activity in which they characterized their school, students, and teaching practice.

For the final course activity, as an application of knowledge, each teacher had to focus on one of his or her classes and elaborate a didactic sequence, considering the particular context of the school where he or she teaches. They had to apply and analyze it based on their practice and research, referenced in the field literature from throughout the course. For this activity, it was suggested that they use DICT capable of contributing to the objectives established in the elaborated plans. Additionally, they should choose one of the methodological proposals addressed during the course. As a means of accompanying and contributing to the analysis of the activities developed by the teachers, they were asked to complete reports, in which they had to include the complete lesson plan, the expected results, and the consulted references. Additionally, the report had to bring a survey of theoretical research regarding the topic of investigation and an analysis based on the practical experience and the readings. In general, the course promoted in the teachers: a greater use of video-class available on-line, in preparing for class, as an object of study for teachers as well as to be used as an aid in the classroom; a greater use of digital learning objects; an expansion of online communication of teachers with their respective students; indication of websites for their students, complementing school content and seeking DICT that could contribute with the teaching-learning process of Physics.

Moreover, the teachers started investing more time in the planning of their activities, in the reading of articles in the research field of Physics Teaching, in the searching of new didactic methodological strategies for the teaching of Physics and of a more efficient use of the DICT, in regard both to teaching and to maintaining a process of continuing education. **Figure 4** presents the degrees of agreement of the teachers in regard to these issues.



**Figure 4.** Relative to the level of teacher agreement after participating in the course. (Source: The authors.)

In this sense, the teachers adopted a more critical posture and started questioning themselves more frequently in regard to the selection of content for each grade level and context, to the relevance and the function of the Physics contents for the desired education and for the world understanding, to the strategies employed, to the participation of students in the teaching-learning process, to evaluation and to the role of DICT in current society and its contributions to the construction of knowledge and the constitution of individuals in the digital era.

### Final Considerations

In consideration of the fact that most of the teachers had not used these technologies in the teaching and learning process and some had not made any personal use of them, their integration within the teaching and learning process of Physics happened more quickly than expected. It can be inferred that the development of the activities and discussions around the pedagogical practice resulted in the comprehension of the critical and creative use of the DICT. However, it is important to clarify that an integration such as this is a slow and gradual process.

Given the purpose of having a critical integration of the DICT, a proposal of education cannot disassociate a command over the technique from that of content and pedagogy. In this sense, the adoption of TPACK was crucial for promoting the use of DICT in the activities planned by the teachers. In the context of the use of computer technologies, command over technology, pedagogy and content must always be banded together and in constant harmony. However, the

current challenges continue to be in the determination of the quality of use of these resources for educational purposes.

The DICT used helped the teacher come out of isolation and the option of having problematizations and circulations as a starting point encouraged interactions, collaborative productions and its use in the teaching-learning process in Physics. Using the set of resources with their course colleagues, noticing its potential, the teachers planned practices that permitted its integration within their own practices. This happened because, in the first place, the starting point was the teachers' own demands and questions, which required that the course be planned in a dynamic and intense fashion, coherent with the references adopted in this research. Secondly, because the resources were presented in such a way as to instigate their use, through problematizing circulations. Although it had some limitations, the constitution of the Virtual Community of Practice met the objective of knowledge-sharing and practice-sharing, of socializing material and of disseminating information about current topics in Science and Technology and events in continuing education. What was sought and exercised was a process of reflection in action, motivating the search for solutions in the confrontation of complications present in the practice, with the support of the DICT, without presenting answers elaborated in advance. The teachers' extensive workload poses a barrier that needs to be broken with urgency. Organizing time for research, readings, planning and analysis becomes difficult because of it.

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