Teachers' Knowledge in the Post-2020 Technological Context: Theoretical Reflections for Teachers' Education[1]

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ABSTRACT

Background: The Covid-19 pandemic has brought about social, cultural, and educational changes. The isolation to which we were subjected has transformed how we see society, relate to each other, express emotions, and carry out schooling. Will the existing literature on teacher education, widely used in teacher education, be able to meet the "new normal"? **Objective:** To relate the theoretical contributions to teacher training and analyse, considering the educational perspective and the technological knowledge necessary for the teacher's work after 2020. **Design:** To this end, we undertook bibliographic research, with interpretive analysis. **Results:** After relating the theories of Shulman, Perrenoud, Imbernón, Nóvoa, Mishra, and Koehler, we found that the authors, each in their own way, highlight the relevance of continuing education and so teachers prepare to face the changes and integrate the DICT in their remote or face-to-face classes. The ruptures are part of the educational routine; it is up to the teacher, from their reflective practice, to rebuild their knowledge to meet the needs of the different scenarios today. **Conclusions:** Thus, the theoretical bases presented constitute practical bases for the teaching performance, since acting in uncertainty in the face of changes and ruptures in teaching and learning models, with the establishment of a new pedagogical composition, has implied reflections on teaching knowledge about teacher education processes.

Keywords: Teacher education; DICT; Changes; Ruptures; Reflective practice.

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Conhecimentos docentes no contexto tecnológico pós 2020: reflexões teóricas para a formação

RESUMO

Contexto: A pandemia da Covid-19 provocou mudanças sociais, culturais e educacionais. O isolamento a que fomos submetidos, transformou a forma como vemos a sociedade, como nos relacionamos, como expressamos emoções e como a escolarização é realizada. A literatura existente sobre a formação de professores e que é amplamente utilizada da formação docente conseguirá atender ao "novo normal"? **Objetivo:** Relacionar as contribuições teóricas para a formação docente e analisar, considerando a perspectiva educacional e os conhecimentos tecnológicos necessários para o trabalho do professor, pós 2020. **Design:** Para tal, empreendemos uma pesquisa de cunho bibliográfico, com análise interpretativa. **Resultados:** Após relacionarmos as teorias de Shulman, Perrenoud, Imbernón, Nóvoa, Mishra e Koehler, constatamos que os autores, cada qual ao seu modo, destacam a relevância da formação permanente e assim os professores se preparem para enfrentar as mudanças e integras as TDIC em suas aulas, sejam elas remotas ou presenciais. As rupturas fazem parte do cotidiano educacional, cabe ao professor, a partir da sua prática reflexiva, reconstruir seus conhecimentos a fim de atender as necessidades dos diferentes cenários que se apresentam no contexto atual. **Conclusões:** Assim, as bases teóricas apresentadas, constituem bases práticas para a atuação docente, uma vez que agir na incerteza diante de mudanças e rupturas dos modelos de ensino e de aprendizagem, com o estabelecimento de uma nova composição pedagógica, tem implicado em reflexões sobre os conhecimentos docentes, sobre os processos de formação de professores.

Palavras-chave: Formação de Professores; TDIC; Mudanças; Rupturas; Prática reflexiva.

INTRODUCTION

The year 2020 was a watershed year for the world. The Covid-19 pandemic has brought about social, cultural, and educational changes. The isolation the disease mandated on us has transformed how we see society, relate to each other, express emotions, and, of course, how schooling is carried out.

The necessary transformations spread worldwide as fast as the pandemic, impacting the social and educational contexts. In 2020, the school scenario was full of challenges for teachers, students, and parents, with empty schools and the emergency remote teaching (ERT).

The challenges triggered reflections and discussions in the academy about the paths to take to prepare teachers for their classroom performance,

which involved rethinking both initial and continuing education and their theoretical references.

Researchers agree that educational scenarios are constantly changing in an increasingly vertiginous way and were boosted during the Covid-19 pandemic. However, when students have any learning deficit, the teacher is the first to be blamed, which makes us ask think again on how the teachers are being prepared to face the current challenges.

As members of society, during this pandemic, we have witnessed the educational segment supplanting the world of ideas in the technological potential for the "concretion of the possible teaching based on technologies", each sector in its own way and at its own pace. As for teaching, it was necessary to exceed the expectations about using technologies for education and do what was possible within the reality of each educational context (Richit & Oliveira, 2021, p. 05).

In 2020, a rupture abruptly changed the school's modus operandi: mandatory social isolation caused the total suspension of classes and the implementation of remote classes. This situation continued in 2021, along with attempts to resume face-to-face teaching. The immunisation of the population made it possible to return to in-person classes in most Brazilian cities in 2022 and with that, teachers had to cope with new challenges. It is a fact that students quickly appropriate the use of digital information and communication technologies (DICT) in the learning process. However, access to technologies and the internet is not homogeneous in Brazil. Consequently, during remote teaching, there were gaps from the point of view of the construction of knowledge and development and attitudes.

The transformations that occurred as of 2020 have irrevocably changed the scenario and characteristics of teaching work, boosting the use of digital technologies for communication between teachers and students. "The digital age has imposed itself on our lives [...], society and education". (Nóvoa, 2021, p. 2). Students, even though natives in a society "that is inserted in a specific environment and that will be [is being] impacted by new technologies" (Schneider & Schneider, 2020, p. 51), also found it hard to cope with the uncertainties and remote learning.

For the teachers, those situations revealed that they needed some knowledges that were not part of the ones thought to be developed during their education. Education, teacher education, and teacher work have been reconfigured and, particularly during the pandemic, with the intensive use of

the DICT - which cannot be left aside with the return of students to schools. Once it has been used both for communication with students and to facilitate teaching and learning, the expectation is that the teaching practice will take into account the experiences of this pandemic period for the composition of their practice in person.

Throughout 2020, with social isolation implemented, teachers -who used to use the DICT only to plan their classes- began to use them in the processes of communication and relationship with students, which mostly took place through technological means. In this context, for the continuity of the teaching and learning processes, the classes needed to be replanned, so that they were developed in the remote modality, which, in itself, constituted a huge challenge for many teachers (Oliveira *et al.,* 2020). There was an "overnight" shift in the educational landscape towards using digital technologies, in which teachers had to rebuild their knowledge and restructure practice.

The overnight changes, which came suddenly as the pandemic, left marks both in society and in the educational field, and some of them tend to remain because they bring innovative solutions to exceptional situations. The pandemic intensified the development and boosted the use of digital technologies in the most diverse human social and communication procedures, leading to digital transformation in society. In this context, we ask: *Does the existing literature, which discusses teacher education and is widely used by teacher educators and researchers, meet the needs of post-2020 teaching, considering the changes imposed in the educational scenario?*

Considering the unexpected transitions in teaching work from 2020 onwards, with the insecurity caused by the public health conditions that impacted the students' school attendance and demanded flexibility in school processes for teaching and learning, we reflected on teacher education. We focused mainly on the knowledge that the teacher will need to deal with the new practice compositions and confront the new teaching challenges post-2020. This reflection led us to discuss the theories of renowned authors in this area, such as Shulman, Perrenoud, Imbernón, Nóvoa, Mishra, and Koehler in different contexts of the digital age.

We start this discussion with the assumption that theories in teacher education complement each other and can help us understand the current movement of reconfiguring teaching work. Therefore, the objective of this text is to give an account of the theoretical contributions to teacher education and analyse them, considering the educational perspective and the technological knowledge necessary for post-2020 teachers' work.

THEORETICAL REFERENCES

In the last two decades of the 20th century, teacher education began to be researched, and teacher professional development was widely investigated. The teachers have emerged as builders of their knowledge, and research on knowledge, knowing, and teacher professionalisation has expanded.

When carrying out investigations in this context, we highlight researchers such as Shulman, Tardif, Schön, Zeichner, Perrenoud, Imbernón, and Nóvoa, whose ideas have served as a theoretical framework in the area of teacher education.

Shulman was one of the pioneers and developed, in the late 1980s, the theory on the knowledge-based theory and the process of pedagogical reasoning. His studies have influenced researchers since then, such as Mishra and Koehler. Tardif, in turn, investigated the nature of knowledge mobilised by teachers in teaching action: professional knowledge. Zeichner pointed out that the teacher's knowledge is built from the action developed when teaching and, like Schön, defended that the teacher is a reflective professional and not just a rule enforcer. Schön's research influenced Perrenoud.

Perrenoud considers that reflecting should be one of the exercises of the mind that individuals use the most to analyse and evaluate their actions, whether before or after an action. This concept of reflection can be applied to teaching, however the hesitation consists of knowing whether reflecting on actions makes the teacher a reflective being. When dealing with reflection on action, teachers are based on their own actions. And in the conception of reflective practice, they can reassess concepts and knowledge that provide opportunities for critical action.

Back in 2001, Perrenoud already invited us to reflect on teaching to act in urgency when he raised some questions, such as: "What is the place of the school next to the media and the methods of "self-education" based on computer technologies?" (Perrenoud, 2001, p. 26). The author also pointed out that one should rethink axes, such as reorganising, and thematising academic knowledge according to the limits and demands of practice, experience and circulate them, confront them with each other, and relate them to academic knowledge (Perrenoud, 2001).

From this perspective, Perrenoud (2001) proposed ten skills necessary for the teacher to teach, mobilising knowledge and processes that integrate and

allow doing, thinking, and appreciating the teaching and learning situation. Likewise, Imbernón (2011) proposed that besides being subjects, teachers should assume the leading role in their education and, consequently, in their professional development. Nóvoa (2009), in turn, argues that teachers' education takes place in the context of teaching activities, based on teachers' self-reflection and self-knowledge, supported by their life stories and professional identity.

According to Nóvoa (2009), teacher education should encourage a critical-reflective perspective of reality that provides teachers with the means for independent thinking and facilitates the dynamics of self-education.

In the 1920s, Brazil started an educational reform movement, in which teacher education was identified as one of the main interferences in the "quality of teaching provided in educational systems" (Leite, Ghedin, & Almeida, 2008, p. 23). From then on, teacher education began to be analysed from several perspectives, and the authors above lead the references for educational research and discussions.

The Brazilian educational reforms ranged from basic to higher education, with proposals that required new knowledge from teachers, as the pandemic has demanded until now. This scenario of constant changes must reflect on the ways of developing teachers' initial and continuing education.

The reality of the classroom goes beyond theories, models, and techniques. Classroom practice is complex, different, and unexpected every day. Proof of this was how teaching was developed during remote classes, when the teacher needed to reflect and play the role of a professional, i.e., be based on specialised knowledge built through education and teaching practice.

In this context, researchers such as Shulman, Perrenoud, Imbernón, Nóvoa, Mishra, and Koehler obtained results and developed their ideas under different prisms, however always approaching teacher education. This field of research, based on contributions from the humanities and social sciences, began to focus on teachers' learning processes and professional development models, allowing for multi and transdisciplinary perspectives (Nonato, 2011).

Considering the digital society and with Shulman's multi and transdisciplinary and well-informed view, Mishra and Koehler (2006) proposed the technological pedagogical content knowledge (TPACK) model. TPACK is a theoretical model that elucidates knowledge for teaching with technology, as well as the knowledge-based theory proposed by Shulman (1986, 1987).

In the TPACK model, Mishra and Koehler added technological knowledge to pedagogical knowledge and content knowledge, and devised a representation considering the intersections between knowledges, which resulted in the technological pedagogical content knowledge (TPACK). It is the knowledge built by the teacher and necessary for their pedagogical practice in a teaching and learning environment equipped with digital information and communication technologies (DICT).

Given all the above, and considering that a teaching and learning environment equipped with the DICT remotely or in-person is becoming the "new normal" for teachers, we understand that this context, as a consequence, will impact the educational system, perhaps promoting a shift in teacher education and discussions in this area. Therefore, it is pressing that the DICT leave the world of ideas and become part of the daily life of classrooms (Nonato & Lobo da Costa, 2021).

METHODOLOGY

The research that supports this article is qualitative, since it has a descriptive and analytical character, with the explicit intention of understanding the situation or phenomenon of investigation, without commitment to generalisations (Amado, 2017).

Qualitative research can be typified -and based on the objective and the problem- and designed as bibliographic, which consists of "collecting, selecting, filing, and archiving information related to the research" (Amaral, 2007, p. 01).

The bibliographic research does not repeat what has already been published on the subject but performs "the examination of a topic under a new focus or approach, reaching innovative conclusions", bringing new knowledge about the researched topic (Lakatos & Marconi, 2003, p. 183). In this sense, we started the bibliographic research by delimiting the theme, proceeding with a bibliographic survey, elaborating the problem, deepening, selecting texts, filing, analysing and interpreting, and establishing the conclusions.

In this type of methodology, there is a sequence to be followed. The first thing is to define the topic. We know the literature on teacher education, as we are scholars in the area. With the problem elaboration, we deepened and expanded the bibliographic survey to meet the objective so that we selected the texts and proceeded with the methodological sequence.

In the bibliographic research undertaken, the delimited theme was "Formação docente: considerações teóricas" [Teacher education: theoretical considerations]. The problem defined was "Identify whether the existing literature, which discusses teacher education and is widely used by teacher educators and researchers, meets the needs of post-2020 teaching, considering the changes imposed in the educational scenario" for further deepening and expansion of studies on those theorists (Shulman, Perrenoud, Imbernón, Nóvoa, Mishra and Koehler), intending to relate the theories, analysing their contributions to dealing with the post-2020 educational situation, particularly regarding the technological knowledge necessary for the teacher's work.

The selected academic works followed criteria appropriate to the research topics, according to the authors' interpretation. The selection criteria were: classic and/or more recent articles and texts by those authors that discussed the listed topics, namely: reflective practice, professionalism, knowledge built by teachers and teaching identity.

As indicated in the bibliographic research methodology, after identifying the academic works, we registered them to proceed with the analysis and interpretation. The first analysis performed was of the thematic type. Thematic analysis is not linked to a specific framework, and can be used in different theoretical frameworks for different purposes. It

> may be an essentialist or realist method, which recounts participants' experiences, meanings and reality, or it may be a constructivist method, which examines how events, realities, meanings, and experiences, and so on, are effects of a series of discourses that operate within society. (Braun & Clarke, 2006, p. 07)

Using the thematic analysis method, patterns within the collected data are identified, analysed, and reported. The idea is to organise the data into sets. This organisation causes recurrences and details that can sometimes be interpreted in numerous aspects of the researched topic. The different thematic analyses must be described in relation to the choices considered as a method by the researcher.

In the thematic analysis, we looked for repeated patterns of meaning, in this case, the themes listed. Subsequently, we undertook the criticism of the material, classifying the key ideas and relating them to the DICT. Not all material selected after the thematic analysis underwent criticism and went on

to the final analysis. Then, we analysed the material for the domain of quality and scientific significance for the research objectives and question.

With the key ideas, after the criticism, the last stage of the bibliographic research was developed, in this case, based on the interpretative analysis. According to Severino (2007), the interpretative analysis respects the stated idea and promotes a dialogue with the author. In this way, we try to dialogue with the authors and relate theories and themes, reading between the lines, and exploring the richness of the ideas exposed so that, as suggested by the bibliographic research, we can establish new conclusions.

The following section brings the results of the analyses and the discussion around the key ideas extracted from the selected texts written by Shulman, Perrenoud, Imbernón, Nóvoa, Mishra, and Koehler.

RESULTS AND DISCUSSION

When the discussion focuses on teacher education, issues such as reflection, reflective practice, professionalism, and knowledge built by teachers, in addition to teaching identity, come into the scope.

We believe that in the training processes, it is possible to develop professional teaching knowledge and, for this, we rely on studies by Shulman (1986; 1987), who established a base of teaching knowledge. Also, to understand how teachers acquire knowledge, from the point of view of transformation, we studied the experience in the programme "Promover uma comunidade de Aprendizes - Como e o que os professores aprendem: uma perspectiva em transformação" [Promoting a community of learners - how and what teachers learn: a changing perspective] (Shulman & Shulman, 2016).

The teacher's knowledge base for teaching, according to Shulman (1987), is composed of seven (07) categories of knowledge, namely: content knowledge, general pedagogical knowledge, curriculum knowledge; pedagogical content knowledge, knowledge of learners and their characteristics, knowledge of the educational context and knowledge of educational purposes.

Among those seven knowledge categories, an innovation proposed by Shulman (1986) was the pedagogical content knowledge (PCK), which means the union between pedagogical knowledge and content knowledge. The author identified the gap between knowledge and knowing how to teach, determining the PCK as a specific category of teaching knowledge included in the category

of practical knowledge. In Shulman's (1987) conception, PCK refers to "the ability of a teacher to transform the content knowledge he/she possesses into pedagogically powerful forms adapted to the variations of the students taking into account their experiences and backgrounds" (Shulman, 1987, p. 13)

The author seeks to value the teacher's practice through the transformation and construction of knowledge that is characteristic of the teaching profession. With research developed in case studies, Shulman (2002; 2003) used theoretical models portraying how teachers learn through structured critical reflections on their own practices. The core of the research was to analyse how teachers can transform individual experiences into concepts disseminated through individual and collective reflection, besides reading and writing case studies.

Being protagonists in the narratives, teachers benefit from written cases, both as active and as reflective narrators (Shulman, 2002). When carrying out this action, the revision of concepts, such as those of teaching, assessment, and learning, is favoured. Those conceptions influence teaching practice, the construction of pedagogical content knowledge, and the genesis of relationships between theoretical aspects linked to teaching and intrinsic situations of school daily life.

Shulman and Shulman (2016, p. 123) believe that "a competent teacher is a member of a professional community and is prepared, willing, and able to teach and learn from their practical experiences". In theory, the teacher must be prepared (have vision), be willing (be motivated), be empowered (know how to do and be able to do), be reflective (learning from experiences) and be communitarian (actively participating in a professional community). All those dimensions concern aspects of personal and professional development, and should be part of a programme of initial teacher education and continuing education.

Perrenoud and Shulman agree that the teacher must be reflective. Perrenoud adds that as a tool, reflective practice is essential for teachers to exercise their craft consciously.

Based on Donald Schön's works, Perrenoud positions the reflective paradigm as a source of change in the teacher's way of acting, reinforcing their bond with the students, their way of seeing reality, establishing a connection between reality and the classroom for problem solving.

According to Perrenoud, the professional teacher must gather skills that include specialised academic knowledge and practical experience. When

acting, teachers never start from zero; they have a background that enables them to develop procedures to solve problems, a form of invention that the classroom situation demands. For the author, a teacher's professionalisation is procedural and progressive throughout the career and, in this aspect, education has a preponderant role.

> Initial and continuous education, although not the only vector of a progressive professionalisation of the teacher's profession, continues to be one of the propellers that allow raising the professional's level of competence. Besides increasing their knowledge and savoir-faire, it can also transform their identity, their relationship with knowledge, with learning, with programmes; their vision of cooperation and authority, their sense of ethics; in short, it can make this new craft emerge (Perrenoud, 2002, p. 12).

The author considers reflection in action the teachers' way of acting in a moment of urgency, when they cannot wait, and establishes that reflection on action is the evolution of professional knowledge. Therefore, the teacher must reflect on what happens in the classroom, develop strategies, and resume at an opportune time.

The teacher faces many surprises in the pedagogical practice. They find that there are no magic formulas, no certainties, and this situation demands respect, interaction, and dialogue. Thus, a reflective posture is a tool that helps teachers develop quality in their work, it is a matter of *habitus* that, along with the traditional form of erudite knowledge, must be allied to practice. Perrenoud argues that teacher education should value and extend their pre-service practices so prospective teachers can develop skills that cannot be taught through theories.

In the classical model, theory precedes action. In the reflective model, theories are developed from action; thus, the teacher must use their practice as a living laboratory, allowing them to face setbacks, seek solutions, and intervene in any situation of challenge in the classroom.

Perrenoud presents ten requirements, without chronology or hierarchy, for reflective practice that:

- compensates for the superficiality of professional education;
- favours the accumulation of knowledge and experience;
- provides an evolution towards professionalisation;

- prepares to assume political and ethical responsibility;
- makes it possible to face the increasing complexity of tasks;
- helps to experience an impossible craft;
- offers the necessary means to work on themselves;
- encourages facing the irreducible otherness of the learner;
- increases cooperation among peers;
- increases innovation capabilities (Perrenoud, 2002, p. 48)

We summarise those requirements in the central idea of the teacher's construction of meaning, whether from work or life itself. The reflective paradigm is fundamental in professionalisation; it is an open power assumed by the responsible correspondents by negotiation with those involved in the educational process.

Perrenoud presents the requirements of practice in the reflective model considered by Imbernón as the ideal education model, as long as it includes collaborative practices and creates spaces for improvement, innovation, reflection, and research.

> Education takes on a role that transcends teaching that aims at mere scientific, pedagogical, and didactic updating, and becomes the possibility of creating spaces for participation, reflection, and training for people to learn and adapt to live with change and uncertainty. People's learning and ways of making it possible are more emphasised than teaching and that someone (assuming the other's ignorance) enlightens and serves as an educator (Imbernón, 2011, p. 15).

According to the author, educational practices regarding teacher education should be observed, aware of the need for change. In this context, in relation to the teacher's role, there must be a redefinition, since it is necessary to have an education professional who knows how to use new methodologies and technologies.

When discussing the need for change in the teaching profession, Imbernón (2011) points out that the teacher must abandon the concept of a mere transmitter of information. Considering the teacher's role in this context of changes in the educational institution, there is consequently a need to redefine the teaching profession; in other words, a different education professional is

needed. In this sense, initial and continuing teacher training needs to incorporate new methodologies, new techniques, as a result of the redefinitions of the education professional that will need to be qualified for the current context.

Teacher education must prepare teachers for uncertainties and changes, as highlighted by Imbernón (2011). Teachers must receive education on a continuing basis, given the changes that recurrently permeate contemporary society.

For Imbernón (2011, p. 69),

> It is necessary to establish an initial formation that provides valid knowledge and generates an interactive and dialectical attitude that leads to valuing permanent updating as a function of the occuring changes and creating strategies and methods of intervention, cooperation, analysis, and reflection, building a rigorous and investigative style.

According to the author: "in the coming decades, the teaching profession will have to develop in a changing society, with a high technological level and a vertiginous advance of knowledge". Teacher education will not be limited to a "disciplinary, curricular, mediating, ethical, institutional, collective preparation, it will be also an important sociocultural baggage" (Imbernón, 2011, pp. 34-35).

Imbernón (2011), aware of the societal changes, points out that teacher education processes must have strategies to promote the development of technological knowledge, since they are part of a society increasingly permeated by digital media.

Imbernón's prediction in 2011 became an emergency due to the Covid-19 pandemic in 2020, which may return at any time with a new epidemic or exceptional situation. Digital technologies were the possible means to keep in contact with students without face-to-face attendance and, consequently, to enable classes to continue. In addition to everyday knowledge, teachers needed specialised knowledge in digital technologies and how to insert them into remote classes.

Brazilian researchers, such as Almeida and Valente (2012) and Kenski (2013), have emphasised the potential of DICT for teaching and, therefore, consider the appropriation of technology resources relevant for the teacher to help student learning.

Especially as of 2020, technological knowledge (TK) has become essential but insufficient. It was necessary to add it to the pedagogical content knowledge (PCK) and also to the technological content knowledge (TCK), creating the TPACK (technological pedagogical content knowledge)

Based on the theory formulated by Shulman (1986; 1987), Mishra and Koehler (2005) described the types of knowledge required by the teacher for adequate pedagogical practice in a technology-based learning environment. In the digital age, the technology considered is the digital information and communication technology (DICT), and a teaching and learning environment equipped with them, remotely or not, whether with computers or with smartphones, has become increasingly present in classrooms.

Mishra and Koehler (2006) proposed the TPACK based on Shulman's (1986; 1987) studies for the knowledge base for teaching, adding technological knowledge (TK) and exploring how it intersects with pedagogical knowledge (PK) and content knowledge (CK), considered by the authors as essential for the development of a class with the integration of the DICT.

TPACK is not just the intersection of knowledge, "it is the interdependent and situated knowledge that is needed to effectively integrate digital tools and resources into curriculum-based teaching" (Harris *et al.*, 2017, p. 01) and how technologies can be used in the construction and development of new knowledge or strengthen existing knowledge (Koehler & Mishra, 2008).

Koehler and Mishra (2009) highlight the importance of considering the teachers' and students' context, as not all of them have the same type of access to DICT or receive basic subsidies to implement this type of technology or even have the necessary knowledge to put in practice the ICTs in teaching.

Regarding social and contextual factors, the authors state that "they complicate the relationship between teaching and technology. Social and institutional contexts often do not support teachers' efforts to integrate technology into their work" (Koehler & Mishra, 2009, p. 61). Lack of resources and inadequate teacher education mean that teachers do not think they are prepared enough to use ICTs in the classroom, and often do not appreciate its value or relevance to teaching and learning.

TPACK requires a range of specialised knowledge from teachers, which must be presented and discussed in teacher training, preferably in initial education. This knowledge includes not only basic technological competence but also an understanding of the unique characteristics of specific types of DICT that would support specific aspects of teaching and learning processes. A

teacher who effectively integrates digital technology into their practice can draw on broad content knowledge and pedagogical knowledge, in combination with technological knowledge. The intersection of the three areas of knowledge, i.e., the knowledge of technological and pedagogical content, defines, for the authors, the integration of effective technology for teaching.

Nóvoa (2020) highlighted teachers' work during the pandemic, when changes were latent, and the use of DICT and the need for specific knowledge for it:

> As I have already said, the best responses to the pandemic did not come from governments or ministries of education. They came from teachers who, working together, could keep a bond with their students to support them in their learning. In many cases, families understood the difficulty and complexity of teachers' work better. (Nóvoa, 2020, p. 10)

For the author, the collaboration between teachers is linked to this professional assuming their role as builders of knowledge and pedagogy, having them deepen in the future the experiments and innovations manifested during the pandemic. It is now a question of not only teaching "classes" but of preparing, guiding, and supporting the students' work with the use of the DICT. Nóvoa highlighted it is urgent to modify teacher education programmes, considering their connection with other professionals, for the construction of a professional identity that is at the same time personal and collective.

Teacher education must guarantee the teacher space and time for self-knowledge and self-reflection, starting from their experiences and personal life stories to form their professional identity. This trajectory must go through processes of pedagogical composition that allow them diverse elaborations and autonomy to build their teaching practice based on professional knowledge (Nóvoa, 2020).

For Imbernón (2016), the quality of teaching must be a constant goal of the school, and it also depends on teacher education. About quality, the author remarks it is:

> (...) a generic polyhedral construct, relatively confusing, where we can imagine that the concept of quality is not static, there is no consensus on it, nor is there a single quality model, since it depends on the conception of the school, the teachers, and of education and teaching. (Imbernón, 2016, p. 16)

The quality of education is not just in the school, it goes beyond the school environment. For this, education must:

> Help consolidate the democracy of the peoples, and for that it must favour a democratic process in its teachings. Today, there is much to be done: it is necessary to overcome the great inequalities, to raise the expectations of many children and adults. Education must become a right for all and not for the privileged on the planet. Education is a patrimony of humanity; and everyone, without exception, has and should be entitled to it. (Imbernón, 2016, p. 86)

Imbernón (2016) emphasises the need for innovation in teacher professionalisation for a new education of the present and the future, and this teaching professionalisation implies mastering specialised skills and abilities that make them competent in a given job and that, in addition, unite them to a professional group. To reconstruct a way of thinking about the teaching profession, "it is necessary to understand the *thickness* of the present and act for the construction of *another school*, not for its disappearance" (Nóvoa, 2021, p. 03). According to the author,

> There is a need for a culture that develops a new process of initial and ongoing formation; a new, more reflective, more practical initial education; greater contextual and ongoing education based on innovation projects. Support more the work of the teaching staff, not forgetting the development of the person, of the teaching subject as an important factor in the profession. (Imbernón, 2016, p. 124)

As for the teachers' permanent education, it seems that the transition (change) is not simple because it is about transforming the professional culture. The teachers' permanent education increases the innovative impact of teaching, something that will not happen if the education remains crystallised. Imbernón points out that:

> To change education, it is necessary to change the teaching profession, and training is a good tool, but not the only or only one, but it must be accompanied by a change in the environment where this teacher performs his teaching work. (Imbernón, 2016, p. 145)
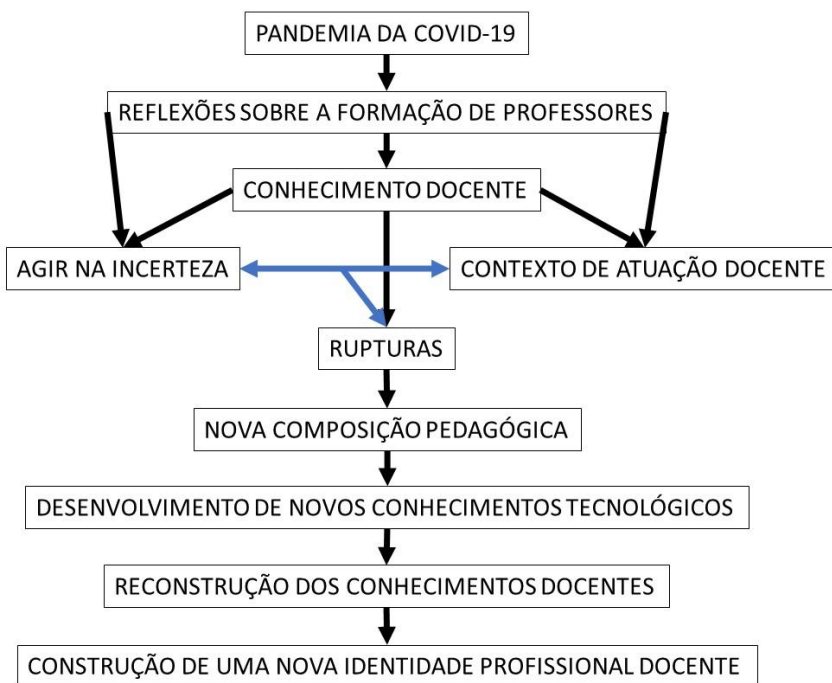
Imbernón (2016) says that the school should be the focus of ongoing education and the teacher, the active subject and protagonist of such education.

He also says that continuing education should support, create scenarios and encourage teachers to reflect on their teaching practice in schools and territories.

In addition to teacher education, the listed authors share some points of their theories, as discussed in the text. Figure 1, below, presents a summary of the research developments reported in this article.

Figure 1

Implications of the Covid-19 pandemic in the context of teacher education

As observed in the course of the text, over the last decades, the theorists we studied – exponents of teacher education – defend formation based on reflective teaching practice. Such a practice is constantly changing, especially in a scenario of uncertainty. Furthermore, the authors argue that it is not enough to have knowledge of content, pedagogy, and technology. It is necessary to have

knowledge of the teaching function and performance, mobilised to solve problems inherent to the professional routine.

Discussions and reflections involving initial and continuing teacher education have resulted in the insertion of, albeit slow, changes in these processes, but little by little, new technologies and new methodologies have been introduced in the classroom context. However, it is worth considering that to implement innovative ideas, we must provide teachers with an education that helps them build pedagogical knowledge, especially those connected with technological knowledge.

Over the last few decades, teacher education –from degree to stricto sensu programmes – has gradually introduced the DICT to develop knowledge for teachers. Theoretical discussions concerning teacher education continue to advance.

In March 2020, with the beginning of the Covid-19 pandemic in Brazil, one of the implications was the presence of discussions and reflections on teaching knowledge in various forums of educators. The teacher needed to act in uncertainty, understand their teaching context and, with that, break with crystallised teaching models in force for a long time. For an expressive number of Brazilian teachers, the ruptures occurred because of the need for action at a time of destabilisation of the modes of conduct and teaching. When considering the context of the teacher's performance and the local characteristics in which they were inserted, a new pedagogical composition was necessary.

The change in the current pedagogical composition was especially fostered when there was the possibility of experiencing and implementing emergency remote teaching (ERT). For this implementation, the teaching actions promoted, besides using DICT, essential for mediating teaching and learning processes, led to the development of technological knowledge for professional performance. Thus, notably, the TPACK model was implemented, implying a new teaching professional identity in the face of an emerging sociocultural context.

Shulman stated that these changes in teaching practice happen from a process in which the teacher reflects. Thus, as Perrenoud highlighted, the importance of the teacher to develop reflective practice arises. When the teacher reflects on the practice and identifies their lack of knowledge in dealing with different DICT in pedagogical practices, the need to adapt and construct new knowledge becomes evident, which they can seek in different courses and qualifications.

In an interview in 2019, Shulman advises teachers: "never stop educating yourselves broadly... the best way to help students learn an idea in your field is to connect it to things that are happening outside your field of action" (Born, Prado & Felippe, 2019, p.19)

Shulman, Perrenoud and Imbernón highlighted that teachers must be in constant formation and, thus, prepared to integrate the technological resources available for remote and in-person classes. Changes are part of the educational routine. It is the teachers' responsibility, from their reflective practice, to build and/or adapt their knowledge to meet the needs of different scenarios.

In 2020, Nóvoa exposed reflections on the Covid-19 pandemic and the future of education, emphasising that the teachers' collaborative movements are extremely relevant to teaching practice to assist, validate procedures and actions, and increase self-confidence. For Nóvoa, collaboration has become crucial for the search for pedagogical possibilities in light of the challenges presented by the educational system. Through collaborative movements, teachers not only gave emotional support to each other but found the necessary support to build new knowledge using digital technologies to re-signify their practices, normally thought of in a more individualised way.

Considering the above and Figure 1, we infer that there is a complementation between the studies of the listed theorists that helps us understand the current movement after 2020. This movement is aimed at reconfiguring the educational scenario and teaching work, especially regarding the construction of new knowledge and the teaching professional profile in the digital age, with the creation of a new pedagogical composition that goes beyond the classroom as a space for teaching and learning from other environments and modalities.

CONCLUDING REMARKS

The context of digital culture and the exceptional moment caused by Covid-19 presented a new performance scenario for the teacher that was perpetuated even with the return of face-to-face classes. It is time to discuss initial and continuing education and, in particular, to highlight the importance of teachers developing the knowledge needed by society. Understanding the particularities of this knowledge to exercise teaching and the dimensions of professional and personal teaching development becomes essential for the present day, in which new school environments have emerged, mediated or not by the use of technologies.

Today, after the Covid-19 pandemic, it is impossible to imagine the educational system without the DICT, the internet, or the virtual environment. But, we must separate this new pedagogical composition from distance learning, and must not reproduce the usual classes of this teaching modality, imagining that digital technologies are neutral or can bring ready and miraculous solutions.

Given this moment when society learns to live with the pandemic and ruptures, in the educational context, each teacher should innovate their practices, preceded by analysis and reflection on what is done and why they should change or maintain pedagogical actions. The source of innovation is endogenous; reflective practice mobilises awareness and fosters the elaboration of alternative projects.

After 2020, the already ongoing changes in education intensified in how the teachers conduct their classes and in the interaction between those involved in the teaching and learning processes. Students are changing, and so are teachers, as they are increasingly involved with the possibilities of digital technologies for teaching and learning. In this aspect, teachers must adapt to a new pedagogical composition in which digital technologies are inserted.

When analysing the authors' ideas, we found that Shulman and Imbernón studied the teachers' knowledge construction, contributing to advances in the theme, especially pointing out that this knowledge is never ready, i.e., it must always be reconstructed due to the constant changes and adaptations, depending on the educational scenario education of the time.

Shulman was a pioneer in research on teacher knowledge. By showing that the teacher's knowledge is never ready, he left gaps for other researchers. From this, Mishra and Koehler inserted technological knowledge into the list of knowledge necessary for teachers to teach. The development of society portrayed that the use of DICT in teaching and learning processes has become inevitable, and Mishra and Koehler point out the relevance of teachers building knowledge related to those technologies.

The pandemic highlighted the need for changes in the teacher's posture. Especially in remote teaching, their reality changed and required the ability to adapt to different contexts, including integration of the DICT into teaching, as if this were something usual for the teacher.

With the gaps in initial teacher education, Nóvoa underlines the urgency of changes in these programmes as well, encompassing the collaborative connection with other professionals for the construction of the

teaching professional identity. The author also points out that the best responses to the educational needs posed by the changing scenario of the pandemic were given by working with teachers, who reconstructed their knowledge by incorporating the use of the DICT, and, mainly, rebuilt their professional identity.

In the process of rebuilding knowledge and professional identity, the teachers went through another process, the reflection process —a reflection during practice and on teaching in a moment of urgency. The moment of urgency was the emergency remote teaching (ERT), totally unknown to most teachers, especially with the use of the DICT, also not always known and available to teachers for teaching. Perrenoud emphasises that professional competences are always changing based on the complexity of the act of teaching, so he has invited teachers to carry out these reflections since 2001, considering the entire teaching and learning process of the student as a process of self-education for the teacher.

The digital age is characterised by the speed with which society changes, but the school seemed to remain unchanged. The pandemic caused a transformation in schools, destabilising this immutability. Questions about what remote classes would be like and how teachers would face this scenario motivated reflections, not only among teachers but also in society.

Teachers began to reflect on their formation and whether the knowledge built in the initial education was sufficient, since they had to act in uncertainty, as it became part of their context of action. In addition to the knowledge learned during their formation, the teacher needed to put into practice empathy, values, and skills to deal with students who were losing family members, and to replan classes.

The use of DICT in teaching left the world of ideas and became part of the real world, with no time for continuing education, promoting ruptures in knowledge crystallised by teachers. Classes through DICT originated a new teaching composition, in which some teachers' technological knowledge was built during the pedagogical practice. This destabilised their knowledge, causing them to reconstruct learned knowledge, such as pedagogical knowledge, for example, which now needs to incorporate the use of the DICT.

This process made the teacher build a new professional identity, with new knowledge, skills, aptitudes, values, and emotions. The post-2020 teacher has finally started the process of building technological knowledge.

Therefore, we conclude that the theoretical bases presented here, although created, elaborated, and thought in an educational context prior to 2020, what humanity experienced with the Covid-19 pandemic created a conducive context for theoretical bases to be configured and constituted on practical bases and proposals for the teaching performance, since acting in uncertainty in the face of changes and ruptures in the teaching and learning models, with the establishment of a new pedagogical composition, has implied reflections on teaching knowledge, on the processes of teacher education and the teaching professional identity.

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Data sharing is not applicable to this article as this is a publicly available bibliography research.

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