RETHINKING INNOVATION IN EDUCATION FROM A CROSS-CULTURAL PERSPECTIVE: THE ROLE PERFORMED BY DIGITAL INFORMATION AND COMMUNICATION TECHNOLOGIES (DICT) IN PEDAGOGY CHANGE

REPENSANDO A INOVAÇÃO EM EDUCAÇÃO SOB UMA PERSPECTIVA TRANSCULTURAL: O PAPEL DESEMPENHADO PELAS TECNOLOGIAS DIGITAIS DE INFORMAÇÃO E COMUNICAÇÃO (TDIC) NA MUDANÇA PEDAGÓGICA

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Abstract: *Recent challenges in education, caused by changes in the economy, society, health or even the pandemic force educators to seek innovative pedagogical practices, design new activities or reformulate existing standards in the classroom. Although such practice-oriented actions are creditable, more systematic and in-depth reflection is needed on how to conceive innovation in education, as well as how to implement changes in teacher education couses. Since there is a clear relationship between culture and ways of teaching and learning, a cross-cultural analysis of research involving innovation in education and the role of technology in this dimension will likely show different ways of conceiving, evaluating and implementing innovation. The aim of this article is to bring different perspectives on pedagogical innovation from different cultures in order to weave interpretations about innovation in education and which dimensions it is related to. Therefore, an analysis is carried out in national and foreign publications over the last five years on which perspectives have been attributed to innovation in education. Preliminary results suggest that there is a multifaceted trend regarding the understanding around innovation in education, and this perspective varies significantly between the national context and the outlook of foreign publications.*
Keywords: *Innovation. Educational Technologies. Teacher Education.*

Resumo: *Desafios recentes na educação, provocados por mudanças na economia, sociedade, saúde ou mesmo pela pandemia obrigam educadores a buscar práticas pedagógicas inovadoras, projetar novas atividades ou reformular padrões já existentes em sala de aula. Embora tais ações orientadas à prática sejam louváveis, é necessária uma reflexão mais sistemática e aprofundada sobre como conceber inovação na educação, bem como de que forma implementar mudanças nos cursos de formação de professores. Uma vez que há a clara relação entre cultura e formas de ensinar e aprender, uma análise transcultural em pesquisas envolvendo inovação em educação e o papel da tecnologia nessa dimensão provavelmente mostrará diversas formas de conceber, avaliar e implementar inovação. O objetivo deste artigo é trazer diferentes perspectivas sobre inovação pedagógica de diferentes culturas de modo a tecer interpretações sobre inovação em educação e a que dimensões está relacionada. Para tanto, é realizada análise em publicações nacionais e estrangeiras no período dos últimos cinco anos sobre que perspectivas vêm sendo atribuídas à inovação em educação. Resultados preliminares sugerem que há uma tendência multifacetada quanto ao entendimento em torno de inovação em educação, e este olhar varia significativamente entre o contexto nacional e o panorama de publicações estrangeiras.*
Palavras-chave: *Inovação. Tecnologias Educacionais. Formação de Professores.*

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Introduction

Over time, concepts and frameworks linked to the technological sphere have been almost "naturally" associated with the perspective of innovation in education, whether in teaching foreign languages, with greater contact between speakers of different languages, or in areas where the presence of different tools, applications, and technological devices is greater, as in natural sciences and health areas, for example. More recently, TPACK and Computational Thinking have been gaining space in the literature not necessarily linked to the scope of innovation, but of the knowledge needed by teachers and students from all areas in the 21st century.

Considering this, the objective of this research is to verify what publications in different countries point out regarding the perspectives of innovating in education and what emphasis they attribute to dimensions regarding teachers' role and competence, ICT, among others. Specifically, through a broad qualitative analysis of articles, dissertations and theses published in the last 5 years we seek to present in the conceptual and epistemological scope of the educational field the following issues: a) what is innovation and why to innovate in education; and b) to what areas/dimensions this innovative process is being related.

Following a qualitative approach with an interpretive basis, we present associations between the theoretical and the empirical fields in order to respond to the proposed objectives.

Background to the study

Innovation in education – definitions and kinds

The relationship between innovation and education is somewhat complex, especially when considering historical and cultural elements, very much based on important philosophical currents, regarding the logic of innovation aligned with the modes of production and consumption of capitalist societies (Silva and Oliveira, 2020). In this perspective of capitalist logic, to innovate would be a synonym of creativity to increase the production and productivity of the system, especially by linking to new technologies capable of revolutionizing what is established as a standard in the economy (SILVA OLIVEIRA, 2020). This logic then enables innovation as a condition for the survival of capital.

On the other hand, in the educational field, innovation must be aligned with a change in the established order, which is necessary for school development. In such a scenario, "innovation seeks to break the bureaucratic routine, as well as contributes to the building of bridges necessary for the positive transformation of structural and complex problems in the school" (Silva and Oliveira, 2020).

The risk for such bridging is always present, as is certain discomfort generated by changes. Innovation refers to "novelty", strives to "renew". Schools and universities, students and teachers are in constant interaction with a historical-cultural context, increasingly permeated by digital information and communication technologies (DICT). They are not subjects or structures orbiting this context, but remain in constant interaction, changing and being changed in a dialectical way.

In this sense, as Monteiro (2019) points out, the idea of innovation as a savior is older than we think. Similarly to SILVA OLIVEIRA (2020), the author adopts the perspective that innovation has always been a requirement for the development and expansion of wealth in capitalist countries. Technology is fundamentally present in the innovative process in a decisive way for scientific advancement through investment in research and development. Therefore, it is almost inevitable to associate innovation with ideas related to technology, production, economic growth, wealth generation and many others, typical of the existential condition of capitalist society.

Besides this social and economic view, the concept of innovation has been associated in education with intentional, rather than accidental, changes. It is something consciously assumed in order to qualify educational action. Therefore, thinking about innovation in the educational field implies changing existing practices and concepts, in an intentional, systematic and planned way, as opposed to spontaneous changes (Silva and Oliveira, 2020).

In search of teachers' postures with DICT, Tagarro et al. (2019) problematize this perspective, recognizing the interaction between face-to-face classrooms and distance education, as well as the significant qualification of e-learning courses in Brazil. On the other hand, this is an example of many countries in which, admittedly, there are problems with access to adequate infrastructure for the employment or effective integration of technologies in education, especially in public basic education. This scenario has possibly been exposed worldwide due to the difficulties experienced by millions of students and teachers at this level throughout the COVID-19 pandemic and the need to suspend face-to-face classes across the country.

It is also possible to affirm that DICT are present in teaching practices, but are negatively influenced by institutional issues, by teachers' reduced knowledge about them and by the great financial deficiency of public education in countries like Brazil. Therefore, the questions pointed out by Jonassen (2000), involving the conception of technologies as cognitive tools, that is, students' intellectual partners, and not merely tools at the service of the teacher or student, take on quite serious proportions when dealing with scenarios weakened by these problems.

Innovating presupposes change. DICT are indeed aligned with the perspective of innovation in education, although they are not unique or mandatory to an innovative process in education. These technologies are known to enable or demand social practices that are oriented at (and guide) new cognitive processes that, in turn, organize new learning for students. As Wertsch (1985) points out, they are cultural instruments that, once introduced into the flow of human actions, guide and alter the subjects' social, cultural and biological practices.

Within this same cultural dimension, Nóvoa (2007) has already stated that fashion is the worst way to face educational debates, because adhering to something new simply because it is new eliminates pedagogical thinking. Innovation, on the other hand, presupposes "a personal and collective work of reflection, appropriation and change" (Nóvoa 2007, preface). The technologies, therefore, must be inserted in this search for new conceptions and pedagogical practices, which reinforce the role of the teacher and his/her capacity to respond to the unpredictable situations of daily school life (Nóvoa, 2007).

Dealing with such challenges is something deeply important. Almeida (2008) illustrates part of this process in Portugal, reporting the drastic change that occurred in that country, with the reality of a computer for every 13 students in 2005 decreasing in 2007 to 8.5 students within the Technological Education Plan (TEP). In Brazil, data from the same period went back to the sad reality of one computer for every 350 students, with the goal of reducing that number to 50 students by 2011, creating partnerships between the government and telecommunications operators in both countries in order to provide free internet connection.

The pandemic caused by COVID-19 is certainly putting these issues back on top of discussions involving innovation in education. The central issue, highlighted by Kurtz (2015; 2016; 2020a), when comparing the conception involving the integration between technologies and education and the teacher's role and training, is that both countries had, at certain moments, similar proposals even with such continental differences. Both presented programs aimed at certification and offering courses involving ICT in teaching.

However, the crisis that still occurs today in the Brazilian context, in general, is largely due to the resistance of many educational sectors to the creation of a technological culture, something that occurred more significantly and earlier in other countries from Europe. This culture effectively covers epistemological, conceptual, methodological bases and, above all, an expansion of the digital inclusion process from the subject's emancipatory perspective.

Obviously, the insertion of technologies in the educational context does not produce significant results by itself. This will only be possible from the moment that the DICT are conceived, by the teachers, in a simple way, without great anxiety. Hence it is imperative that, as Miranda (2006) notes, teachers have deep contact with computational resources since their initial training, which, in fact, initially familiarizes them with the use of these tools for educational purposes.

In this same context, Garavaglia (2016) emphasizes that innovation is the result of a process of creation. According to the author, referring to Wagner's study (2012), creation is crucial

to innovation, so that essential elements of innovation are motivation, expertise and critical thinking. Like Garavaglia (2016), Tang and Wu (2020) highlight the students' creative potential is enormously compromised by the so-called "traditional education", known as exclusively organized by the transmission of content. The authors' criticism of courses aimed at innovation in education also extends to the evaluation of these courses which, according to the authors,

> Focuses on asking students to write or design innovation and entrepreneurship plans, and has not been really put into the specific "actual combat" of innovation and entrepreneurship. [...] Teachers of innovation education courses are not provided with professional training and practical operation, and lack of professional teachers with professional background and practical experience. (TANG; WU, 2020, p. 71).

It is evident, then, that the theme of innovation in education crosses different dimensions, as we have tried to illustrate throughout this review. It requires, as Tang and Wu (2020) as well as Liu et al. (2020) point out, a great collective effort on the part of teachers, who, in turn, need adequate training to be able to assist the innovative educational process.

In this regard, in the recent studies by Kurtz and Silva (2020a; 2020b) the TPACK framework (MISHRA KOEHLER, 2006; HERRING et al, 2016), with intersections of knowledge necessary to the teacher, is articulated to the concept of Computational Thinking. This last one, based on the work of Wing (2006), is related to the idea that all people (children, youth and adults) must consider/develop in their processes of educational training computational thinking with the aim of constituting "own" knowledge and capabilities inherent to Computer Science professionals.

More specifically, as WING (2006; 2014) defines it, computational thinking consists of an approach to problem solving that explores concepts of computing. In this context, it considers a set of mental processes (mental tools) used by computer professionals when they operate with a view to solving problems through techniques, tools, practices and concepts of computing even without machines. Abstraction, concept formation, problem based learning, etc., are some of Computational Thinking principles.

Therefore, it is important to note that, following recent research, innovation in education can be associated to the following dimensions:

a) In a historical-philosophical perspective, it is linked to the logic of capitalist modes of production and consumption, synonymous with creativity, with a focus on increasing the system's productivity.

b) Elements essential to innovation (in education or not) involve, above all, creativity. Allied to this are motivation, specific knowledge of the area, and critical thinking skills.

c) It is equivalent to changing the *status quo*, that is, to the renewal of processes, concepts and practices established from the recognition and meaning of the knowledge produced and accumulated by past generations.

d) It can be associated with DICT, either due to the global and economic nature associated with the great powers and companies in the technological area, or in a critical perspective, inclusion and empowerment of the subjects.

e) It must be conceived as an intentional and not a causal process, that is, it is something consciously assumed with a focus on the qualification of educational action.

f) In a pedagogical perspective, it involves a paradigm shift, teacher-student relationship, curriculum, teaching methodologies, learning environments and routes, etc.. In a technological perspective, even if not mandatory in innovation, it involves much more than incorporation of technological resources in all educational spaces, but it encompasses a significant change to qualify educational processes and achieve expected results, both quantitatively and qualitatively.

g) It breaks with the logic of traditional education, especially due to the conceptual and methodological characteristics of content exposure, which reduces or eliminates the space for creativity, being, therefore, linked to concepts and frameworks specific to each area of know-

ledge or broader, involving knowledge, skills and abilities expected from teachers and students in general.

Below, we specify some developments of these dimensions, specifically the last one, linked to the role and position of teachers in an innovative context.

Innovation adoption by teachers

The ways that teachers perceive innovation can be multifold, and the three most frequent attitudes are withdrawal conditioned by apprehension of novelty, losing authority or personal safety; reception of innovation only when convinced of low risk and personal benefit; and, finally, ardent adoption and trend-setting, characteristic of creative individuals ready to take risk (Zawadzka, 2004). The innovation adoption process is to a large extent individualized, conditioned by the teachers' personal characteristics, teaching experiences, administrative considerations, learners' expectations and needs, logistical allowances, etc. The adoption (more commonly referred to as 'diffusion') process is a complex, dynamic continuum, with many factors influencing the change (Dooley et al., 1999).

In describing technological innovation adoption by teachers, Rogers (1995) suggests that the process consists of five major sequential steps:

1) Gaining awareness of the innovation
2) Forming either a positive or a negative opinion about the innovation
3) Choosing to adopt or reject the innovation
4) Using the innovation
5) Seeking evidence that supports the decision to adopt or reject the innovation

An important part of innovation adoption is the second step, namely "forming either a positive or a negative opinion about the innovation", which, according to Palmer (1993), should lead to 'ownership' or a situation in which those teachers who are more expected to resist innovation will be found more willing to implement it when the innovation becomes 'theirs'. The steps towards technology ownership are as follows (Palmer, 1993):

1) Experiencing the innovation
2) Rejecting the possible impact of the innovation on one's own teaching
3) Adapting the innovation to one's own particular circumstances and teaching style
4) Evaluating the innovation in the light of actual experience

5) It is particularly important for prospective innovation implementators to 'experience' the technological innovation themselves, as is stressed by Palmer (1993). For that matter, applying particular software, tools and procedures in pre-/in-service teacher training on a prolonged basis will hopefully enable teachers to develop a more creative use of the tools in their pedagogical practice. By eliciting the active contribution to the proposed innovation, encouraging the production of materials and adapting ideas to their particular circumstances, ownership and commitment are likely to increase.

Innovation adoption frameworks

Previous research led to the isolation of a number of models along which technological innovation is adopted by teachers. As they come from diverse fields, such as psychology, language teaching methodology and Computer-Assisted Language Learning, they will have different foci. However, it is evident that technology adoption can be structured, monitored and guided through a series of clearly defined steps, according to one or some of the approaches below. It is through technological innovation adoption, then, that we will generalize the process of pedagogical innovation, as the bulk of research has been devoted to new ways of using computers, Internet and mobile phones in the language classroom.

The Concern-Based Adoption Model (CBAM), developed by Hall et al. as early as in 1973, brings the concept of user concerns to the fore, described as "the composite representation of the feelings, preoccupation, thought, and consideration given to a particular issue or task" (Hall and Hord, 1987, cited after Dooley et al. 1999, p. 108). As innovation adopters have diver-

se personal makeup, experience and knowledge, they perceive a given issue differently, leading to various kinds of concerns. In the CBAM model, change is viewed as a process, not a single event, influenced by various motivations, perceptions, attitudes, and feelings experienced by individuals in relation to change (Hall et al., 1973). The key aspect of the model is the notion of the Stages of Concern (SoC), which teachers indicate when involved in the implementation of an innovation. There are three major concern types, namely self-concerns, task concerns and impact concerns, each subdivided as follows:

- Self-concerns: Stage 0 = Awareness, Stage 1 = Informational, and Stage 2 = Personal.
- Task concerns: Stage 3 = Management.
- Impact concerns: Stage 4 = Consequence, Stage 5 = Collaboration, and Stage 6 = Refocusing.

According to CBAM, technology adoption involves the unfolding of an experience and gradual development of a skill towards sophistication in innovation use, moving from non--users to sophisticated users (Dooley et al., 1999).

Chronologically next, yet one of the most influential in total, model of innovation adoption known as 'Diffusion of Innovations' was put forward by Rogers (1983, 1995, 2003). Innovation here is defined as an "idea, practice or object that is perceived as new by an individual or other unit of adoption" (Rogers, 1983), while diffusion is the "process by which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 1983). In this model, the decision to adopt a particular innovation passes through a series of actions and choices over time, starting with the individual first obtaining knowledge of an innovation, followed by the forming of an attitude towards it, finally, making a decision to adopt or reject it, implementing the new idea, and finding confirmation of this decision. The process is influenced by prior conditions, characteristics of the decision-making unit, the perceived characteristics of the innovation, communication channels, as well as the personal characteristics of the teachers.

The individuals in a social system do not adopt an innovation at the same time; thus, the innovativeness dimension is measured as the time in which one adopts a particular technology. Therefore, it is helpful to propose the following adopter categories (Rogers, 1983): Innovators, Early Adopters, Early Majority, Late Majority, and Laggards, which are normally distributed across the entire population in a bell-shaped curve (Anderson et al., 1998).

According to Geoghegan (1994), Innovators (2-3% of adopters) are as equally interested in the innovation as in its application, while Early Adopters (about 10% of adopters) are interested in the possible application of the technology to professional tasks, employing a more reasonable and project-oriented stance. The Early Majority are more pragmatic, wanting proven applications within their disciplines. The Late Majority are similar to the early majority but do not entertain technology, as they feel less comfortable with it. Finally, the last 15%, the Laggards, may never take up the innovation at all. According to Rogers (1983), adoption of innovation occurs inevitably but what distinguishes individual adopters from one another is the rate of that adoption.

The Technology Acceptance Model (TAM) was developed by Davis (1989), who drew from the Theory of Reasoned Action (TRA) proposed by Fishbein and Ajzen (1975). As described by Inedo (2009), the TAM model posits that user acceptance of a new technology can be predicted by their perceptions within the three core constructs:

- *perceived ease of use* - "[t]he degree to which a person believes that using a particular system would be free of effort" (Davis 1989, 320);
- *perceived usefulness* - the user's perceptions of the expected benefits derived from using a particular technology;
- *usage* - "theorized to be influenced by perceived usefulness and perceived ease of use" (Davis 1989, p. 320).

In this particular model, teachers adopting a particular innovation are regarded as reflective, rational practitioners (Sugar et al., 2004), and their innovation adoption decisions stem from the consideration of consequences, social support and available resources. The Theory of Reasoned Action, together with the later Theory of Planned Behaviour (Ajzen, 1985), give

a framework for viewing technology adoption as a change in teachers' everyday instructional behaviours in the practical, real-world context of classrooms and schools today.

Another highly influential research proposal, Markee's (1997) Curricular Innovation Model, is based on the analysis of the factors that determine the success or failure of an innovation: "Who adopts what, where, when, why, and how?" (Markee 1997, p. 43). The model categorizes the roles played by researchers and instructors as innovation participants to be taken in managing curricular innovation. Markee (1997) proposes four different categories: Implementers, Suppliers, Adopters, and Resisters. The Implementer type encompasses people who make use of the new material in the way they receive it without making any changes to it. The Supplier defines the people who create and supply the new material. Adopters accept the new material, see the innovation as a positive change in the curriculum, and adapt it to answer the needs of specific educational environments, while, at the same time, preserving its theoretical and pedagogical bases. Resisters, on the other hand, are those who are in opposition to the material or to the innovation, and, thus, become agents of resistance instead of agents of change. For a curricular innovation to be successful, the participants have to move from a mere implementer position to that of an adopter (Zapata, 2004).

In the Learning/Adoption Trajectory framework (Sherry et al., 2000), gaining knowledge about the innovation is described as a continuous process for all users, whether they are beginners or experts (Sherry et al., 2000). The Learning/Adoption Trajectory stresses the dynamic nature of technology adoption, using a cyclical rather than a linear approach (Sahin and Thompson, 2007): Teacher as Learner, Teacher as Adopter, Teacher as Co-Learner, Teacher as Reaffirmer/Rejecter and Teacher as Leader. Teachers progress through personal and task management phases as they experiment with the innovation, begin to try it out in their classrooms, relive their experiences with their peers, later develop a relationship between technology and the curriculum, conduct action research, observe practice, collect data and share improvements with peers.

According to Bax (2003), the end goal of innovation implementation is achieving the state of normalisation which is defined as the phase in which "the technology becomes invisible, embedded in everyday practice and hence 'normalised'" (Bax 2003, p. 23). The state in which particular elements of computer technology are fully integrated into pedagogy will be achieved when, among other issues, teachers have enough knowledge of and ability to deal with computers to feel confident in using them, innovation is properly integrated into the syllabus, not fully confident teachers are provided both technical and pedagogical support, teachers' concerns about technical failures, and their lack of skills to deal with these will be addressed and overcome by means of reliable support and encouragement (Chambers and Bax 2006).

The adoption of technological innovation by a language teacher proceeds towards normalisation in stages, which are slightly modified categories of Rogers' Diffusion of Innovations (Bax 2003, p. 24):

- Early adoption. A few teachers and schools adopt the technology out of curiosity.
- Ignorance/scepticism. However, most people are sceptical or ignorant of its existence.
- Try once. People try it out but reject it because of early problems. They cannot see its value - it does not appear to add anything of 'relative advantage' (Rogers 1995).
- Try again. Someone tells them it really works. They try again. They see it does in fact have relative advantage.
- Fear/awe. More people start to use it, but still there is (a) fear, alternating with (b) exaggerated expectations.
- Normalising. Gradually it is seen as something normal.
- Normalisation. The technology is so integrated into our lives that it becomes invisible - 'normalised'.

Finally, Cycles of Innovation (Pennington, 2004) moves through cycles involving the introduction of the innovation and its resulting adoption. The innovation is progressively adopted through the three Innovation-Adoption cycles, namely Continuity Cycle, Creativity Cycle and Discontinuity Cycle. As the innovation is adopted, the movement is from a relatively shallow processing of the innovation with minimal adaptation, to a deeper-level processing demonstrated in a major adaptation to and investment in it (Pennington 2004). Each phase includes the Innovation step and the Adoption step, with the former constituted by the introduction of new forms in relation to an existing content, and the latter involving their dissemination or adjustment between the innovation and the context. As the innovation becomes adopted, the influence of the context of introduction decreases and the influence of the innovation itself increases.

The study

Aims and methodology

Considering the purpose of verifying how publications in different countries conceptualise the perspectives of innovating in education, we conducted a broad qualitative analysis of articles, dissertations and theses published in the last few 5 years in order to answer, in the conceptual and epistemological scope of the educational field, the following research questions: 1) What is innovation and why to innovate in education?; 2) Which areas/dimensions is this innovative process related to?

The methodological approach adopted was qualitative analysis with an interpretive basis, also known in Brazil as Discourse Textual Analysis (Moraes and Galiazzi, 2011), considering that this qualitative approach provides content analysis linked to discourse analysis, with data from descriptive stamp. Thus, we consider reality as being socially constructed and the researcher with the role of making this reality explicit throughout the investigation process of its object of study.

Therefore, from the literature and the empirical material selected, we intend to have identified the meaning attributed to dimensions, such as: “Innovation in education”; “Information and Communication Technologies in education”; and “Teaching skills and abilities involving innovation”. Specifically, the texts selected for analysis were brought together and, then, the phase of “fragmenting the texts”, or “unitarization” was initiated. In this phase, the texts were separated by units of meaning, that is, they were analyzed and examined in their details to be fragmented soon after in order to obtain constituent units and significant statements referring to the studied phenomenon. It is from this process that “analysis units” or “meaning units” (meaning units) emerge, which are coded for the purpose of organizing the analysis.

After the categorization process, the so-called “Metatexts” were produced, that is, the analytical textual production was carried out in which the categories were presented and interpreted from the perspective of the constructed theoretical framework, something that is performed on a recurring basis. The theory informs and is informed by the data and categories emerging from them, throughout the analysis procedure.

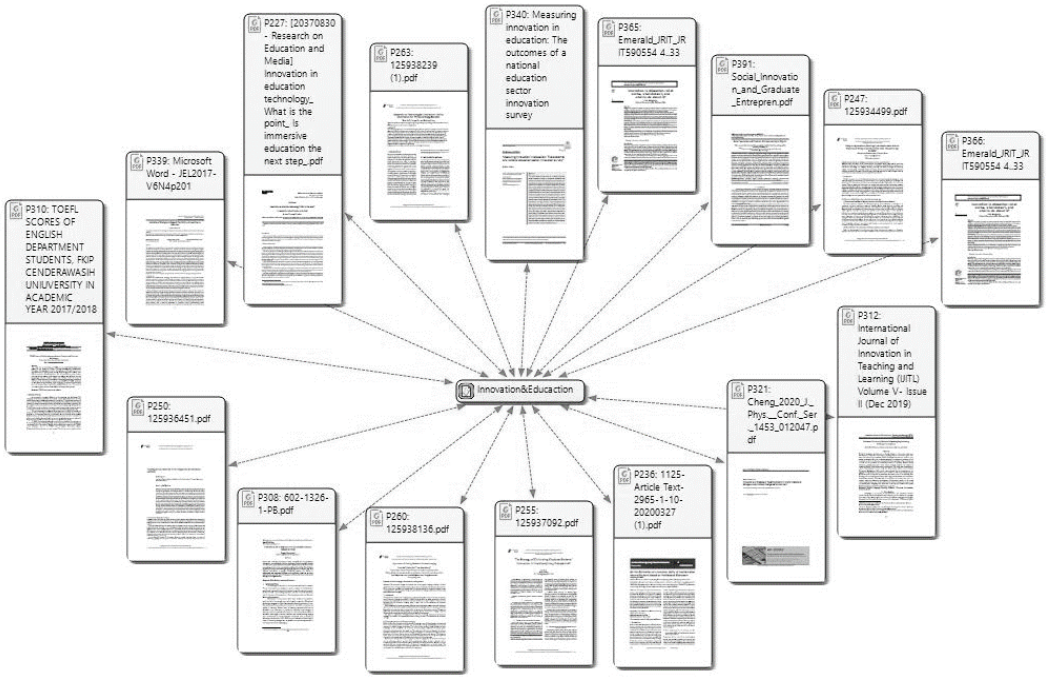
Procedure – corpus analysis

The data analysis process was carried out with the aid of the qualitative analysis software Atlas.ti (Friese, 2012) in the process of organizing the data from the research corpus.

Following the adopted methodological approach, the research corpus initially consisted of 329 texts (articles, dissertations and theses), 173 texts published in English, and written by researchers from several countries, and 226 texts published in Portuguese, written by Brazilian researchers. The texts were collected and stored from two Internet search engines: a) Google Scholar search/notification system; and b) Mendeley article management and sharing software. The period of data collection and constitution of the corpus was from December 2019 to May 2020.

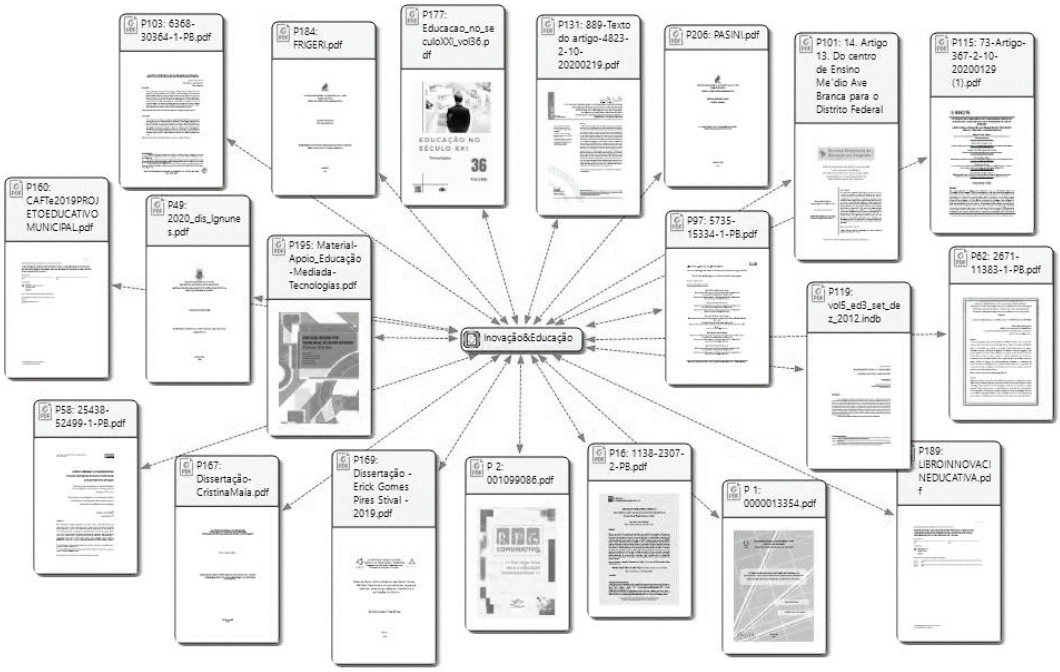
However, the search returned numerous texts that were not included for reading and analysis, as we considered the degree of deepening and theoretical and conceptual articulation involving the previously established dimensions, as well as we sought subsidies in these texts that contributed to the later elaboration of the theoretical scope of the research. Thus, for this stage of the research, out of the 329 texts, the corpus of analysis for identifying units and organizing categories was reduced to 36 texts, with 16 texts in English (Figure 1) and 20 in Portuguese (Figure 2). The analysis with the 293 remaining texts will be conducted in the following stage of the research.

Figure 1. A preliminary categorization of the English samples with Atlas.ti.



Source: Research data.

Figure 2. A preliminary categorization of the Portuguese samples (Atlas.ti).



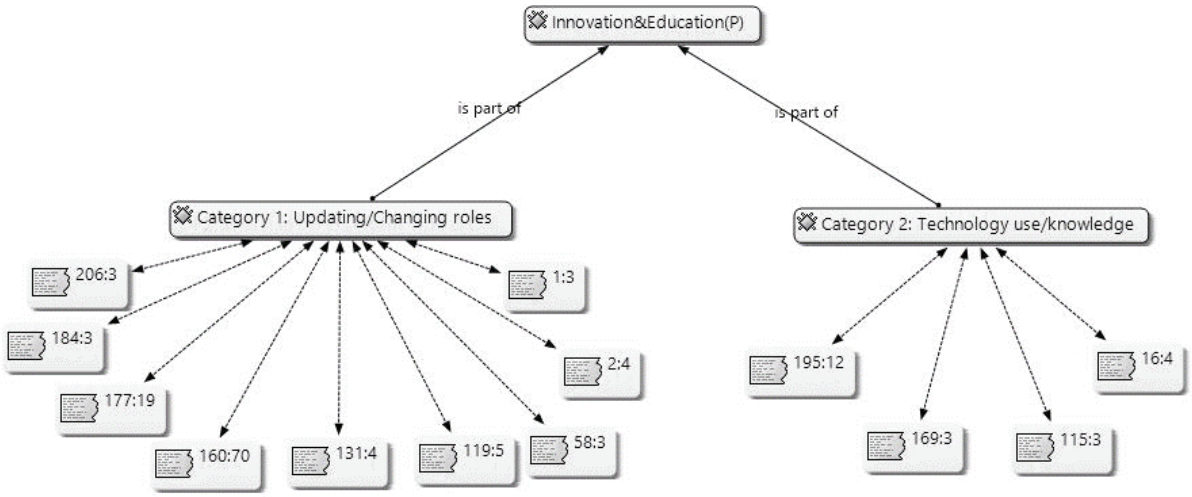
Source: Research data.

As Figures 1 and 2 show, after organizing the corpus, the investigation relied on the qualitative modality of analysis, with the objective of organizing a conceptual and theoretical map explained by the corpus composed of the 36 selected texts. After the compilation of these texts, we had the creation of units of meaning that, later, will compose the analysis categories. Next, we present and discuss the results of this analysis. Texts were categorized according to the letter T (for text), followed by numbering (1, 2, 3, et.c), and the initial of the publication language (P for Portuguese, and E, for English, designating texts from countries other than Brazil).

Results and Discussion

The analysis of texts written by Brazilian researchers showed, in the process of fragmentation of the 20 analyzed texts, about 16 units of meaning that, when reorganized, make up 2 categories, as illustrated in Figure 4. The categories produced are: 1) Innovation in education involves updating and changing the roles of teachers, as well as in their training and in other education agents; and 2) Innovation in education implies the creation, use and technological knowledge, with a pedagogical and social inclusion focus.

Figure 3. Categories produced in the analysis with Portuguese texts (Brazilian researchers) /Atlas.ti.



Source: Research data.

Category 1: Innovation in education involves updating and changing the roles of teachers, as well as their training and other education agents

It is important to highlight that, in line with what the literature in the area has recently pointed out, the "voice" of researchers of the 20 analyzed texts reiterate that innovation in education implies the active presence of the teacher's role, however, with significant changes. Such changes are not a rupture, but a meaning of what permeates the social world and what skills and competencies are necessary for interaction and performance in this world, as illustrated by the excerpts collected from T1P and T131P:

> ***T1P:*** *... implies an interactive change in education professionals and contexts that makes a new reason for teacher training practices based on schools ...*

> ***T131P:*** *... any prospect of improvement or innovation in education requires better training for trainers. Thus, there is a dependency between a highly qualified faculty, attentive to the specific needs of various apprentices and the ability to implement successful strategies for the teaching-learning process[...]*

In addition to the issue of teacher qualifications, which is also extended to initial teacher training, we find that this change does not fall only on the teacher, but also on the content, on the more autonomous role of students, on the infrastructure of schools and universities, due to the interaction in a broader context involving social, global and even economic elements, often guided by regulatory bodies and agencies, such as the OECD, for example. The question of the need for investment in education is linked to this dimension, as the excerpt from T119P illustrates.

> ***T119P:*** *How to implement innovation in elementary and high school? Innovation at these levels will only be possible if investments are made in the quality of education.*

The changes in the teacher's role regarding the condition for innovation are evidenced in the publications. There is an explicit need for a reconfiguration in teaching practices, which involves, in a way, a change not only in methodological terms, but also in content and object, which transcends the mere instrumental character of DICT, interfering with subjects' own understanding of the world.

Category 2: Innovation in education implies the creation, use and need for technological knowledge, with a pedagogical and social inclusion focus

Throughout the analysis, this category was highlighted due to the numerous references to the crucial role of DICT in innovative education. This occurs due to changes in social practices that are, in turn, linked to movements, sometimes of inclusion, sometimes of exclusion. The presence and integration of technologies and education, at different levels, from early childhood education to higher education, is evident in the analysis, and this happens in references to distance education and its peculiarity. It is also related to hybrid teaching, to the use of software in teaching, to such activating methodologies as Problem-Based Education, and also to the need to develop and expand digital literacy or technological fluency in this scenario, as the excerpts from T195P and T169P illustrate:

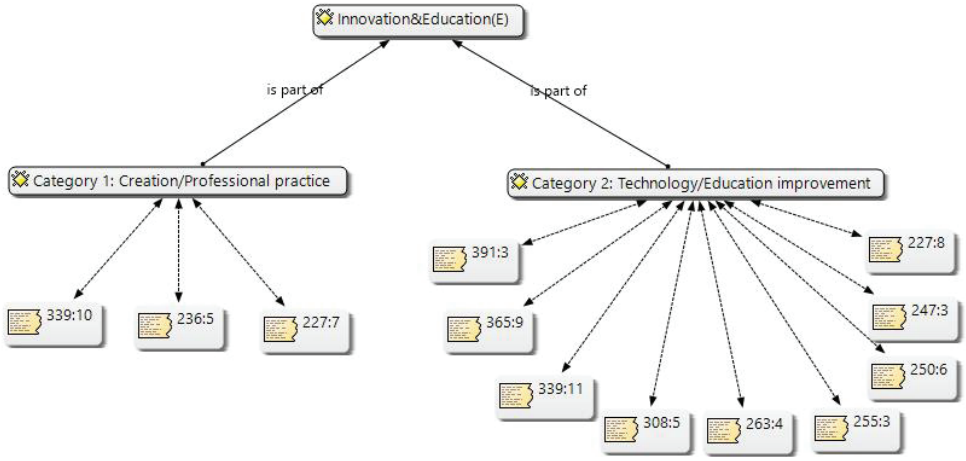
> ***T195P:*** *Based on the evidence from the research made possible by the DBR's ballast, it is possible to affirm that Massive / Small Open On-line Courses (MOOC/SOOC) and REA are powerful to generate innovation in online and open education in higher education [. ..].*

> ***T169P:*** *The use of software in the classroom is already a reality and not accepting this condition is giving up innovation in education [...]*

Thus, the two categories are related to each other, from the moment when, considering the perspective of "innovation in education", two major elements appear to be associated in Brazilian publications: the change in roles, in performance, in the conception of teacher education formative process as well as content, teaching objects, and ways of teaching and learning. To conclude and organize the contrastive analysis, we present below what the analysis in the 16 research texts from different countries and written in English showed.

The analysis of the 16 texts showed two categories: "Innovation in education is closely related to creation and experiences of professional practice"; and "Innovation in education is strongly linked to the integration of DICT in educational contexts and the consequent changes brought about by this relationship", as illustrated in Figure 4.

Figure 4. Categories produced in the analysis with English texts (researchers from different countries) - Atlas.ti.



Source: Research data.

Category 3: Innovation in education is closely related to creation and to experiences of professional practice in training processes

The analysis carried out on the corpus showed great emphasis on the role played by DICT in innovative processes related to education. However, even if in a reduced way in number of occurrences, it was possible to elaborate upon this category, since certain units of meaning could be organized in relation to its very significant role and highlighted in the texts regarding creation and professional practice, even in training contexts:

T236E

> Some colleges and universities still emphasize the imparting of knowledge and neglect the cultivation of students' innovative ability. This kind of traditional education severely restricts students' personality shaping and creative potential.

In addition to the question linked to the development of the creative and innovative potential of students, there are also criticisms of the skills that are developed for innovation purposes. Therefore, reiterating what we also verified in the literature review, it is crucial to rethink the training of teachers in all areas in order to develop skills and competences aimed at innovation and entrepreneurship in their areas.

Category 4: Innovation in education is strongly linked to the integration of DICT in educational contexts and the consequent changes brought about by this relationship

In a very similar way to category 2 built on the analysis of Brazilian texts, this category involves the emphasis given by authors from other contexts to DICT in education and the changes brought about by the effective incorporation of these resources in the educational context, with a focus on qualification of education. However, in addition to the role played by the technologies themselves, the changes triggered by new methodologies, forms of interaction, teaching materials, etc., portrayed a complexity linked both to differentiated teacher education, as excerpts T308E and T365E illustrate.

T308E

Due to the increasing quality of education, it is hoped that there is an innovative idea in improving the quality of education in all types and levels of education. In connection with the expansion of opportunities, innovation is indispensable to enable the secondary education system to reach all school-age youths to gain learning opportunities.

T365E

Technology applications need a solid theoretical foundation based on purposeful, systemic research, and a sound pedagogy. (...) This evolution must be systemic, consistent, and scalable; therefore, school teachers, college professors, administrators, researchers, and policy makers are expected to innovate the theory and practice of teaching and learning, as well as all other aspects of this complex organization to ensure quality preparation of all students to life and work.

Thus, the analysis carried out on the 16 documents produced in different countries raises a relationship that, at times, is congruent with the results verified in the analysis of Brazilian studies, but it also presents a point of detachment in the scenario of other countries. Congruent in the close association between innovation in education and the presence of DICT, that is, for innovation to take place in educational processes, these must be associated with DICT. However, detachment between these scenarios is seen: in the Brazilian context, there are desired and suggested changes to teachers and other sectors of the educational area in order to effectively have an innovative context, while other countries' publications focus on the development of creative capacity demanding changes and better qualification of professionals in the area.

Final Remarks

Concluding upon the results of the research, we can see that, for innovation in education to occur, it is necessary to approach or integrate it with DICT. This is a true premise, as we were able to verify in publications from different countries, with different social, economic and cultural realities.

Therefore, considering the initial motivation of the study, to verify in which terms innovation is conceived in these publications, why it is important to innovate in education, and with which areas or dimensions the innovative process is associated, we realize that the responses are multifaceted and vary between Brazilian publications and those of other countries. However, in addition to variations evident in the categorization presented in the analysis, the challenges imposed on educators around the world, especially with the COVID-19 pandemic, transcend traditional stereotypes and views regarding the role of DICT in the pedagogical process in all areas and at all educational levels. Initial teacher training, basic and higher education, as well as master's and doctoral programs have, in very short periods of time, incorporated, in one way or another, technological resources and tools in conducting classes and interactions with students. Especially, the educational process (with its conceptions, limitations and potentialities) was placed in the spotlight on the part of governments in almost all continents, involving current and future actions by these agents and by the private sector.

Associating this "new" reality with innovation in education is only one of the consequences for the subjects involved in educational activities, and urgently demands new perspectives, methodologies and interactions with different social actors (professionals, specialists, mentors) who must interact effectively and globally, without borders, with educators and students. After all, if innovation in education is aligned with modes of production and is conceived

as a synonym for creativity, it is essential that different human dimensions be aligned in this process.

In a context of paradigmatic transition also in world education, in which artificial intelligence, computational thinking, augmented reality, virtual reality and the internet of things seem to be strong trends in this sector, it is crucial that we have, globally, more and more focused interactions in the constitution of subjects in professional practice and also in training with a very qualified view theoretically and methodologically, and, above all, with a very broad cultural and human constitution.

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