Digital technologies in Mathematics curricula and professional practices of brazilian and portuguese teachers

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Abstract: This article intends to try to understand the curriculum acts of two Mathematics teachers of Basic Education from public schools in the District of Lisbon in Portugal and two teachers from the Municipal network of the city of Rio de Janeiro in Brazil about the use of digital technologies from recent curriculum reforms in countries. The case study has a qualitative methodological bias and analyzes of the discourses of these teachers were carried out, which showed the dynamics of digital technologies in the approach to interdisciplinarity through curriculum flexibility in contexts of mathematical and non-mathematical practices. The dissonance between the teachers' curriculum acts, Mathematics Education and the current curriculum proposals in the countries emerged, as well as the need to expand studies and research in the scope of Digital Literacy and Computational Thinking, so that practices are promoted that develop students' autonomy and creative process.

Keywords: Digital Technologies. Curriculum Acts. Curriculum Reforms in Brazil and Portugal.

Tecnologías digitales en los currículos de Matemáticas y prácticas profesionales de profesores brasileños y portugueses

Resumen: Este artículo pretende tratar de comprender los actos curriculares de dos profesores de Matemáticas de Educación Básica de escuelas públicas del Distrito de Lisboa en Portugal y dos profesores de la Red Municipal de la ciudad de Río de Janeiro en Brasil con respecto al uso de tecnologías digitales de las reformas curriculares recientes en los países. El estudio de caso tiene un sesgo metodológico cualitativo y se realizaron análisis de los discursos de estos docentes, los cuales mostraron la dinámica de las tecnologías digitales en el abordaje de la interdisciplinariedad a través de la flexibilidad curricular en contextos de prácticas matemáticas y no matemáticas. Surgió la disonancia entre los actos curriculares de los docentes, la Educación Matemática y las propuestas curriculares vigentes en los países, así como la necesidad de ampliar los estudios e investigaciones en el campo de la Alfabetización Digital y el Pensamiento Computacional, para que se promuevan prácticas que desarrollen a los estudiantes autonomía y proceso creativo.


Tecnologias digitais nos currículos de Matemática e em práticas profissionais de professores brasileiros e portugueses

Resumo: Este artigo pretende compreender os atos de currículo de dois docentes de Matemática do Ensino Básico de escolas públicas no distrito de Lisboa, Portugal; e outros dois docentes da rede municipal da cidade do Rio de Janeiro, Brasil, no que tange à utilização de tecnologias digitais a partir de reformas curriculares recentes ocorridas nos países. O estudo de caso possui um viés metodológico qualitativo e, a
partir da análise dos discursos desses docentes, evidenciou-se a dinamicidade das tecnologias digitais na abordagem da interdisciplinaridade por meio da flexibilidade curricular em contextos de práticas matemáticas e não matemáticas. Emergiu, ainda, a dissonância entre os atos de currículo dos docentes, a Educação Matemática e as propostas curriculares vigentes nos dois países, bem como a necessidade de ampliação de estudos e pesquisas no âmbito da Literacia Digital e do Pensamento Computacional, para que sejam fomentadas práticas que desenvolvam a autonomia e o processo criativo dos alunos.

**Palavras-chave:** Tecnologias Digitais. Atos de Currículo. Reformas Curriculares no Brasil e em Portugal.

1 Introduction

In Brazil, the National Curricular Common Base (BNCC) (BRASIL, 2017, p. 63), by prescribing one of the general competences that must permeate its components, refers to the digital culture by raising that students should “use digital technologies of communication and information in a critical, meaningful, reflective and ethical way in the various daily practices (including school ones) when communicating, accessing and disseminating information, producing knowledge and solving problems”.

In Portugal, the Ministry of Education and Science (MEC), from art. 6 of the Diário da República, regarding the purpose of the curriculum and its promotion, establishes principles, values and areas of competence that must comply with the development of the curriculum due to globalization and technological development. The intention is to prepare students who will be young people and adults in 2030, emphasizing that, “in order to achieve that purpose, and without prejudice to the autonomy and flexibility exercised by the school, the following principles underlie the granting of the curriculum: […] k) Promotion of learning within the discipline of Information and Communication Technologies; […]” (MEC, 2018, p. 2931).

It is foreseen, by the current guidelines in the country, that the competences defined for Teaching are guaranteed, being prescribed as one of the learning principles in the context of the subject Information and Communication Technologies (ICT). It presupposes ICT literacy for the proper use of tools, reinforced by art. 12, Autonomy and curriculum flexibility, paragraph 4: “In the 2nd and 3rd cycles, the base curriculum matrices integrate the Citizenship and Development component and, as a rule, the ICT component” (MEC, 2018, p. 2933).

Based on these recommendations brought by recent reforms in Brazil and Portugal, Macedo (2013) corroborates by pointing out that, for the analysis of the
contexts of educational practices with the use of digital technologies in the teaching of Mathematics, the concept of “curriculum acts” it is a considered promising bias. These acts presuppose that, in order to try to evaluate the implemented educational policies and “honestly understand the curricular practices for any practical purpose, it is essential to start from their indexities, descriptibilities, intelligibilities and analyzabilities constituted by the members who, in the day-to-day of educational thinking/doing, constitute their curricular ‘orders’” (MACEDO, 2013, p. 431). “Acts of curriculum contextualize, decontextualize, recontextualize, deny, betray.” (MACEDO, 2013, p. 23).

Macedo (2013), in this sense, is supported by ethnomethods, which “are understood as methods that social actors produce when understanding and interfering with their actions in the realities they inhabit, for all practical purposes.” (MACEDO, 2013, p. 14). Within this symbolically mediated actionalist view, the concept coined by us of the curriculum act comes to represent a unique possibility of experiencing how its founding inspirations can enter into curricular issues for the understanding of practices, focusing on the interests of understanding the actions’ instituted and instituting that create what we have learned to call curriculum. (MACEDO, 2013, p. 20).

The author also emphasizes that “curricula are socially constructed realities.” (MACEDO, 2013, p. 23). Contextualizing, historicizing, culturally linking actions and accomplishments is part of a process that cannot be discarded, otherwise it represents the main essence to arrive at the method that characterizes an ethnoresearch of curriculum acts. This ethnomethodology, according to Macedo (2013), is configured as an attempt to understand human realities, to verify how it was produced and implemented and how social actors exercise points of view in different situations, while indexicalization refers in an essential way to the context and daily life.

In this sense, the objective is to understand the curriculum acts of two Mathematics teachers from each of the countries, regarding the use of digital technologies, based on recent reforms. To this end, in this article, their discourses on the aforementioned methodological bias will be analyzed, pointed out by the curriculum recommendations as contributing to the promotion of mathematical learning.

The prescriptions of these countries, when considering the incorporation of digital technologies in curricular components, raise implications for the development of Mathematics programs on their use by students. They bring recommendations on the
development of digital skills for the new generations.

The lack of studies that integrate curriculum reforms, teacher professional development and digital technologies for teaching, as well as these observations, lead to justify and attribute relevance to the study on the adoption of this resource in the education of the new generations, pointed out by research as an indispensable tool for teaching in different areas.

For this reason, questions will be raised about the use of digital technologies, highlighting the need for critical reflection of the challenges brought by the implementation and review of curricular programs in Brazil and Portugal, which have been facing tensions in the recent processes of reform of their curricular documents.

2 Recommendations on the use of digital technologies in current curricular programs in Brazil and Portugal

In the presentation of Mathematics Curriculum Programs and Goals for Basic Education (PMCMEB), in Portugal, perspectives are brought regarding the use of technologies:

Students are also asked to carry out several tasks that involve the use of drawing and measuring instruments (ruler, square, compass and protractor, dynamic geometry programs), and it is desirable that they acquire dexterity in the execution of rigorous constructions and recognize some of the mathematical results behind the different procedures. (DGE, 2013, p. 13)

The document “Curricular management guidelines for the Basic Education Mathematics Program and Curriculum Goals” (OCPMCMMEB) (DIREÇÃO GENERAL DE ENSINO – DGE, 2016) also contains examples of work with digital technologies:

Scratch, which, in addition to an introduction to a programming language, consequently involves logical mathematical thinking, estimation, coordinates in referential and variables, among other aspects; number applets (eg. number lines) and algebraic applets (sequence generators, multiple representations, algebraic modelling, ...); Excel, as one of the possible digital applications, as it allows making the transition between the numerical and the algebraic approach, namely with the reproduction in a table providing multiple representations. (DGE, 2016, p. 4)

In the reform that took place in the Portuguese curriculum with the proposal of the document Aprendizagens Essenciais (AE) (MEC, 2018)\(^2\), it is also recommended

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\(^2\) In August 2021, New Essential Learnings for Basic Education were approved, which are still in the implementation phase. Available at: [https://www.dge.mec.pt/aprendizagens-essenciais-ensino-basico](https://www.dge.mec.pt/aprendizagens-essenciais-ensino-basico)
that the insertion of digital technologies in the context of students throughout basic education develops:

[…] the ability to appreciate aesthetic aspects of mathematics and to recognize and value the role of mathematics in the development of other sciences, technology and other domains of human activity; develop the ability to recognize and value mathematics as an element of the cultural heritage of humanity. (MEC, 2018, p. 3).

In Brazil, working with digital technologies is also mentioned in the BNCC (BRASIL, 2017) as a resource to support Mathematics learning:

In addition to the different teaching resources and materials, such as checkered meshes, abacuses, games, calculators, spreadsheets and dynamic geometry software, it is important to include the history of Mathematics as a resource that can arouse interest and represent a significant context for learning and teaching Mathematics. However, these resources and materials need to be integrated into situations that encourage reflection, contributing to the systematization and formalization of mathematical concepts. (BRASIL, 2017, p. 292)

The BNCC document (BRAZIL, 2017) for the construction of Brazilian curricula also suggests the adoption of resources, such as calculators, electronic spreadsheets and dynamic geometry software, highlighting the need to insert the history of Mathematics and reflective processes in the concepts’ approaching, configuring itself as a general recommendation and without clarity of its objectives.

In addition, it emphasizes mathematical problem-solving, research and development processes, considered potentially rich for the addition of fundamental skills for mathematical literacy (reasoning, representation, communication and argumentation) and for the development of Computational Thinking (BRASIL, 2017).

The latter is evidenced in the description below:

Another aspect to be considered is that the learning of Algebra, as well as those related to other fields of Mathematics (Numbers, Geometry and Probability and Statistics), can contribute to the development of students’ computational thinking, given that they need to be able to translate a given situation into other languages, how to transform problems, presented in the mother tongue, into formulas, tables and graphs and vice versa. (BRASIL, 2017, p. 269)

The document brings perspectives on the development of Computational Thinking, in which students must translate a problem situation into a specific computational language, create algorithms and flowcharts, highlighting the
intersections between algorithmic and algebraic language (variable concept). This should be accomplished through the identification of patterns, generalizations and properties.

The reform of the Brazilian curriculum with the implementation of the BNCC (BRASIL, 2017) points to the use of technologies and other resources for the representation, systematization and formalization of mathematical concepts. The Basic Education Mathematics Program (PMEB) refers to the use of dynamic geometry software combined with other instruments for students to develop dexterity in rigorous geometric constructions and recognize related results.

Similarly, in the BNCC (BRASIL, 2017), in the AE (MEC, 2018) and in the OCPMCMEMB (DGE, 2016) digital technologies are identified as tools for changing tables (primarily, from numerical tables to algebraic tables), representation, systematization and formalization of the concepts that will affect the digital literacy of students in different contexts. These curriculum documents prescribe the use of devices and applications that presuppose knowledge, understanding, skills and dispositions to use technologies effectively, aiming to provide, create and communicate information and concepts.

Regarding the development of Computational Thinking, the programs of both countries focus on the transition between numerical and algebraic languages through multiple representations in problem situations. Specifically, the BNCC (BRASIL, 2017) brings skills inherent to the development of Computational Thinking from the perspective of the development of algorithms in the Algebra unit, considered very specific and, sometimes, dissociated from the pointed knowledge object prescribed in the BNCC.

In the AE (MEC, 2018) it is recommended the use of devices and applications aiming at understanding and skills for the use of digital equipment capable of promoting the creation, communication, prediction and description of solutions, but without clarifying their real objectives (CANAVARRO et al., 2019). In the OCPMCMEMB (DGE, 2016) perspectives are presented on initiation to the programming language, development of mathematical thinking and digital applications, which presuppose the development of competences related to Computational Thinking.

3 Literature Review
In investigations on Digital Technologies carried out by researchers, such as Dick and Hollebrands (2011), it is emphasized that their strategic use strengthens the teaching and learning processes. Gadanidis and Geiger (2010), Roschelle et al. (2010) and Suh and Moyer (2007) give the same emphasis, adding that the strategic use of digital technologies can support the learning of procedures, as well as the development of advanced skills. Regarding Basic Education students' attitudes towards Mathematics and the role of teachers, it is corroborated that:

School Mathematics often distances itself from life Mathematics, that is, what we learn at school is not used in our relationships as members of a society, in which every day it is necessary to master technologies related to Mathematics. On the other hand, professionals working in these areas need to master these contents to be able to perform their duties. (SOARES, 2010, p. 5)

Therefore, the teacher needs to have theoretical knowledge that supports the action and helps him to plan his classes with the use of technologies. The perspective is for a meaningful mathematical learning that allows students to build mathematical concepts through a reciprocal dialectic, awakening in them positive attitudes towards Mathematics.

With regard to the use of calculators in the classroom, Faria (2007), Machado (2012) and Frant (2011) evidence the technology-student interaction, which allows student autonomy during tasks. Nunes (2011, p. 19) emphasizes the use of “graphic calculators as a technological resource for Mathematics Education and that we must use them in the face of reflective planning, during the elaboration of activities that contemplate the exploration and potential of this resource in learning”.

The opinion of the National Council of Teachers of Mathematics (NCTM) (2015) reinforces technology tools for teacher and student use through decision making that keeps mathematics, not technology, as the teaching focus. To define the use of technology, teachers and curriculum designers must focus on the capabilities of the available tools and attend to the possibilities presented by emerging technology, highlighting the mathematical learning objectives. Uses should not be limited to those required by external assessments and students should develop procedures that include the use of technology.

The use of ICT at school helps in the social promotion of the group's culture, norms and traditions. At the same time, a personal process is developed that involves
style, aptitude and motivation. The exploration of images, sounds and simultaneous movements are, for students and teachers, opportunities for interaction and production of knowledge.

Therefore, it is necessary to use technologies in non-mathematical contexts that allow integration between knowledge. The subjects' view of these devices, the contexts, the phenomena and the way in which they are presented to the students are guiding elements of the technology implementation policy in school curricula.

The Organization for Economic Co-operation and Development (OCDE) highlights key points for curriculum analysis that are being discussed within the scope of the Mathematics Curriculum Document Analysis (MCDA) subproject, part of the OECD project "Future of Education and Skills, Education 2030", which aims to carry out a broad comparative study of world prescriptions in order to help countries find answers about what knowledge, skills, attitudes and values are needed for students to thrive and shape their world, as well as ways that education systems can effectively develop them, that is, it aims to support countries in addressing common curricula implementation challenges and in identifying critical success factors, with a focus on:

 […] technologies that have not yet been invented, and solve social problems that have not yet been anticipated. Education can equip students with the agency, skills and sense of purpose to shape their own lives and contribute to those of others. Therefore, change is imminent. (OCDE, 2018, p. 1)

The Project also intends to support countries in addressing common challenges in curricula implementation and in identifying critical success factors. Strand 1 refers to the elaboration of a learning framework for Mathematics 2030, and strand 2, to the Analysis of International Curriculum Programs, aiming to build a knowledge base that will allow countries to make curriculum design processes more systematic. This means supporting international peer learning and stakeholder debates.

Thus, the analysis categories defined in the project are highlighted, which also constitute categories among the others in the present study, based on the Mathematics 2030 project and the literature review:

<table>
<thead>
<tr>
<th>Digital Literacy</th>
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<tbody>
<tr>
<td>Digital Literacy refers to the ability to use knowledge, understanding, skills and dispositions to use digital equipment effectively, consciously and appropriately at school and beyond. Students with this ability are able to provide, create and communicate information and concepts (JENKINS et. al., 2009; MARTIN, 2006). They are able to adapt to technological changes and use technologies to achieve a purpose and communicate</td>
</tr>
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Computational Thinking involves the formulation and resolution of problems carried out through technologies. Programming is referred to as a fundamental skill (WING, 2006) and coding in order to build knowledge, through understanding and skills related to the language, patterns, processes and systems necessary to instruct/direct devices such as computers and robots. It should have the function of complementing and combining Mathematics and Engineering, generating ideas and being accessible to everyone in any context (WING, 2006). The relationship between Mathematics and Computing curriculum contents are still far from being identical (BARCELOS; SILVEIRA, 2012).

Through this literature review, it is pointed out the need for studies and research that address issues related to the strategic use of Digital Technologies through interactive processes that involve autonomy and the conscious and critical protagonism of the subjects involved in the educational process.

4 Methodology

Regarding the delimitation of the research method, interviews were carried out with two Mathematics teachers of Basic Education from different public schools, belonging to the grouping of schools in the district of Lisbon, Portugal, and two other teachers who teach in the municipal education network in the city of Rio de Janeiro, Brazil. The schools were chosen within the scope of contacts made for a post-doctoral investigation, whose objective was to study Mathematics Education in the current official curricula practiced in Brazil and Portugal, mainly regarding recommendations on the use of digital technologies.

Interviews were conducted with teachers who confirmed using technologies in their practices and revealed to be in professional practice during the curricular reforms that took place in Portugal and Brazil in recent years. The profile of teachers is shown in table 2.

Table 2: Profile of Brazilian and Portuguese teachers interviewed.

<table>
<thead>
<tr>
<th>Interviewed</th>
<th>Sex</th>
<th>Teaching Time</th>
<th>Initial Formation</th>
<th>Ongoing Formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PB1</td>
<td>M</td>
<td>5 years</td>
<td>Full Degree in Mathematics from UNESA (2014) (7/8 of the time taken at UGF)</td>
<td>Postgraduate in Higher Education Teaching at UCAM (2015).</td>
</tr>
<tr>
<td>PB2</td>
<td>M</td>
<td>Not informed</td>
<td>Degree in Mathematics from FEUC.</td>
<td>Not informed</td>
</tr>
<tr>
<td>PP1</td>
<td>F</td>
<td>24 years</td>
<td>Degree in Mathematics Teaching, University of Évora, completed on May 19, 2000.</td>
<td>Master's Degree in Education, in the area of Didactics of Mathematics, from the Faculty of Sciences of the University of Lisbon.</td>
</tr>
</tbody>
</table>
Aiming at an analysis of the discourses of these interviewed teachers, a literature review and consultation were carried out on the perspectives of using digital technologies present in official documents in force in Brazil and Portugal. This analysis is configured as:

[… a way of collecting qualitative information from a primary or original source of written, printed, and recorded materials to answer research questions in interpretive case studies. The documents provide evidence of authentic or real activities carried out in social and human thinking organizations. (SHARMA, 2013, p. 3)

Individual interviews of the semi-structured type were used, considering that, through it, the interviewees would be allowed to talk freely about fundamental points of the process related to curriculum acts with the use of digital technologies, as Bauer and Gaskell (2002) emphasize.

The interviews were conducted in 2018 and 2019 and recorded in audio. The use of digital technologies in Mathematics classes in their school context was one of the main points of the interview.

The method used to study the data collected in the interviews was discourse analysis. According to Vergara (2010), discourse analysis is a method that aims not only to understand how a message is transmitted, but also to explore its meaning. Such discourse analysis implies considering both the sender and the receiver of a message, and the context in which this discourse is inserted.

For the analysis of the speeches evidenced in the interviews, categories were adopted after a first reading. Here, it was intended to codify (highlight, classify, aggregate and categorize) its excerpts transcribed with Brazilian (PB1 and PB2) and Portuguese (PP1 and PP2) teachers, who presented work perspectives related to the
connections of the use of digital technologies with: (1) attitude towards Mathematics, (2) calculator use, (3) digital literacy, (4) non-mathematical contexts and (5) Computational Thinking.

5 Data presentation and analysis

Regarding the category “Attitude towards Mathematics”, Brazilian and Portuguese teachers emphasized their views on the perspective of the relationship between digital technologies and a positive relationship of students in relation to Mathematics, signaling that:

Students already arrive in class using interesting technological terms like kilobytes, megabytes, gigabytes. Some already associate the powers of 2 to the memories of their pendrives and cell phones, such as 2 gigabytes, 4 gigabytes, 8 gigabytes, 16 gigabytes, 32 gigabytes... Many ask why they don't have 3 gigabytes, 6 gigabytes and why they skip from 8 gigabytes to 16 gigabytes. It is at this moment that Mathematics enters, not as a consequence, but as a cause. I present Mathematics as a tool for technology and not the opposite. (PB1)

Digital technologies are here to stay. There's no turning back or fighting back. I view this relationship with optimism, as everything technological attracts students' attention. However, we need to know how to channel, because it is very easy to “get lost” in this infinity of tools and applications. But, without a doubt, it will be of great contribution and has a lot to add. (PB2)

We live in a technological generation, and I believe that technology is really here to stay and should be used constructively. (PP1)

In my view, digital technologies in mathematics teaching serve as a motivation for students as long as they are well used. (PP2)

The speeches of the interviewees reinforce that the strategic use of digital technologies (DICK; HOLLEBRANS, 2011) strengthens the teaching processes as long as they are well used, being essential for the construction of new knowledge and serving as motivation for this generation inserted in a society increasingly technological (SOARES, 2010; SUH; MOYER, 2007; MARTIN, 2006). Specifically, a Brazilian teacher clarified the example of a situation involving device memories, using terms that refer to technology and introducing mathematics as the cause of such an approach (NCTM, 2015).

Regarding the category “calculator use”, the professors took a contrary position, emphasizing that:

As it's just a recommendation, I don't give it much importance. Forcing the student to do all the math on pencil and paper is like reinventing the wheel. (PB1)

I take the “against it” position. I see the calculator only as an “accounting result accelerator” and not the central object of any activity whatsoever. “Pushing buttons”, by itself, does not show that the student has acquired the planned concepts. In my view, what matters is that the student understands the concepts and reasoning involved in the activity, but it is clear that the teacher
needs to know how to dose and use the tool correctly. (PB2)

There is a setback, as it values only written calculations, when conjectures should be made, going further through processes of discovery and validation. It should be used from the earliest years in an exploratory way, as [...] [in] successive additions translated as multiplication. (PP1)

I do not agree. The calculator is also linked to external assessments, as is done in the 9th grade (end of the 3rd cycle), where a part of the test uses a calculator and the other does not. (PP2)

Brazilian professors showed resistance to the recommendation on the use of calculators: one highlighted the need to use pencil and paper and another classified the resource only as an accelerator of accounts, emphasizing the development of mathematical reasoning. He, however, highlighted, in the end, that the tool could be adopted in a moderate and correct way, without specifying the typology of didactic situations, and that such a resource would be relevant and promising.

Portuguese teachers highlighted the setback of the reform introduced by PMCMEB (DGE, 2013) by emphasizing that the calculator should only be adopted in teaching situations in the most advanced years. It was emphasized that it should be adopted with an exploratory character from the first years of schooling. One of the teachers brought the perspective of its adoption since the early years of Basic Education, since in the Portuguese education system the calculator is adopted on a large scale in part of the assessment.

They were also asked if they remembered any classes from the current or previous year in which they had used the graphing calculator.

I do not use graphing calculators with my students. (PB1)

Unfortunately, I didn’t have that opportunity, but from what I see in everyday classroom life, the graphing calculator would be a very useful tool. For 9th grade students, in particular, it would add a lot. (PB2)

In the 7th grade [it was used] to explore the slope of a line for the study of functions, verifying the role of coefficients, varying parameters in an exploratory way. The students were invited to verbalize what happened through the explorations carried out on the graphing calculator. (PP1)

Yes, in the third cycle with the study of Functions. Also in a situation involving sensors that worked simultaneously with the graphing calculator. The data was collected and the sensors sent it to the calculators. The calculator must be used critically and graphing calculators are essential in the mathematical investigation of the tasks proposed to students. (PP2)

A Brazilian teacher stated that he did not use the graphing calculator and the other highlighted that the tool could be an aggregator for the 9th grade, without, however, explaining contents and approaches. One of the Portuguese teachers exemplified the work in the classroom with the variation of parameters in the teaching of Functions and the oral communication in an exploratory character from the use of
graphing calculators; the other, a didactic situation combined with sensors (FARIA, 2007; MACHADO, 2012; FRANT, 2011; NUNES, 2011). A Portuguese professor also highlighted the need to use graphing calculators critically (JENKINS et al., 2009).

Regarding the Digital Literacy category, teachers were asked whether the most recent programs in the countries bring new perspectives of work related to the use of digital technologies:

Yes. I really enjoyed this part, and it couldn’t be different. The demand for knowledge about new technologies and the use of digital materials forces us to think differently from previous years. An example of this is the Probability and Statistics part. The use of a simple calculator is already necessary when you want to calculate an average and even use a more sophisticated computer to draw a graph or search for information in a database on a website. (PB1)

Yes. There is a competence in the BNCC that emphasizes exactly this: “Understanding, using and creating digital information and communication technologies in a critical, meaningful, reflective and ethical way in the various social practices (including school ones) to communicate, access and disseminate information, produce knowledge, solve problems and exercise protagonism and authorship in personal and collective life.” Digital technologies have become of great importance and have become protagonists in the teaching-learning process, before they were just a “plus”, a recommendation. Now they are at the center of teaching. (PB2)

Undoubtedly, because it calls for the active participation of students with the use of digital technologies. (PP1)

I don’t remember how the document brings it. (PP2)

A Brazilian professor mentioned the demands for knowledge about new technologies and the use of digital materials, which demanded a new attitude from professors in relation to them. In addition, he brought the thematic unit Probability and Statistics as a possibility for the application of resources, such as the calculator and the computer. The other teacher highlighted a competence on Digital Literacy contained in the BNCC, explaining the need for a teaching role in the face of the use of digital technologies, which have come to occupy a centrality in the teaching processes.

A Portuguese teacher highlighted the perspectives of active student participation presented in the AE. They refer to awareness, attitude and ability to use the solutions and dynamisms offered by digital technologies so that students, in their mathematical activities, can identify, access, manage, integrate, evaluate, analyze and synthesize digital resources, build new knowledge, create media expressions and communicate with other colleagues (MARTIN, 2006). The other teacher did not remember the general perspectives that AE, the most recent Portuguese curriculum, brings about the adoption of digital technologies.
In the Non-mathematical contexts category, respondents were asked whether, in terms of official curriculum guidelines, the use of digital technologies was prescribed more for purely mathematical contexts or aimed at promoting mathematical reasoning and communication. They signaled that:

It is prescribed both for mathematical contexts and for reasoning and communication. An example of this is the fact that students today are writing much more than ten years ago. Thanks to the use (by some) of the mobile phone, some apps force students to write correctly and make them more informed, too, about global topics. (PB1)

The answer lies in competence itself. Technologies have assumed a prominent role and will be used to enhance all existing virtues. So, it will not just be a purely mathematical context, but a way to produce knowledge and improve communication. (PB2)

The 2013 program emphasizes reproduction [and] memorization, and the document “Essential Learning” emphasizes reality, context and experience (explanation of thought, reasoning) according to the students’ profile. (PP1)

The 2013 program is too extensive and demanding for the level and age of the students it is intended for. Even not remembering perspectives on the use of technologies, the document “Essential Learning” came to add to the 2013 program. (PP2)

Brazilian teachers were unanimous in stating that the BNCC provides recommendations on the use of digital technologies for both mathematical and non-mathematical contexts. They revealed knowledge of the prescription and highlighted that the document’s perspectives revolve around not only the development of mathematical reasoning, but also the adoption of information and communication technology resources in the face of the demands of the globalized world.

In the report of Portuguese teachers, the PMCMEB (DGE, 2013) was criticized for emphasizing mechanical and plastered learning processes, which goes against the assumptions made about the objectives of Basic Education, according to art. 7 of the Basic Law of the Educational System (LBSE) (PORTUGAL, 2009). It emphasizes that students should be placed in contexts conducive to the development of reasoning. Similarly, Suh and Moyer (2007) point out the strategic use of digital technologies to support the learning of procedures, as well as the development of advanced skills, such as problem solving, reasoning and justifications.

At another time, they were asked if they use digital technologies in non-mathematical contexts, as suggested by the curricula, and if there was any field in the area in which the use of digital technologies was more used in their classes. The teachers interviewed thus responded:

I use some digital technologies in robotics workshops, but always with mathematical contexts. Some situations do involve Arts; for example, where they research color combinations to paint
the robots. I also used the virtual reality glasses last year to show some museums to my students. In this case it was outside the mathematical context. Although I used virtual reality glasses in math class, the idea was to show the importance of using digital technologies.

Statistics — It is most used because it involves a lot of graphs and accounts. I would spend days to draw some graphs on the board that, with the help of a projector and a notebook, I spend two class periods to show the students.

Geometry — It is much simpler to show the animation of a geometric solid being flattened than trying to draw it on the board. It would even be impossible to draw such an animation (PB1).

Yes, in the Life Project and Directed Study classes, as there is no specific menu or schedule for these subjects, I can use technologies more “freely”, thus managing to connect them better. (PB2)

Yes. Interdisciplinary work with different areas, inquiry into citizenship and health and performing data processing. Students have the Information and Communication Technology subject in their curriculum. I always use it in Geometry, Functions and Data Processing. (PP1)

I don't remember using technology in non-mathematical contexts. There is no exact field that uses it more often. (PP2)

Specifically on the adoption of technologies in non-mathematical contexts, one of the Brazilian professors highlighted the use of digital technologies in robotics workshops, primarily in mathematical contexts. However, he took it outside the mathematical context in situations involving Arts and virtual reality. Regarding the thematic unit in which he most uses technologies, he highlighted Statistics, in which he optimized the approach to the graphic part, and the work with animation and solid planning in the Geometry unit. Another teacher highlighted, as a non-mathematical context, the freer use of technologies during the Life Project and Directed Study classes, which do not have a specific menu or schedule.

On the issue of the use of technologies in non-mathematical contexts by Portuguese teachers, the report of one of the interviewees is in line with the guidelines in force in Portugal. They provide that the competences defined for Basic Education are guaranteed, prescribing them as one of the principles of learning in the context of ICT. This discipline presupposes ICT literacy for the proper use of the tools, reinforced by art. 12, Autonomy and curriculum flexibility, highlighting that, in the 2nd and 3rd cycles, the basic curricular matrices include the Citizenship and Development component and, as a rule, the ICT component. This perspective is adopted by PP1 in the fields of Geometry, but also in Functions and Data Processing. PP2 reported not using the technologies in other contexts and that there is no field in which she adopts them more frequently.

The question addressed in the Computational Thinking category dealt with the space given in the classes for its development, how it is approached and what is its
importance in the official programs and in the curricular proposal built in the school. The teachers so reported:

*There is the website “A hora do Código”, which shows how computer programming works in a more playful way through challenges. I used this mechanism a few times in my Directed Study and Life Project classes (disciplines that exist in the SME curriculum).* (PB2)

*Let’s say that Computational Thinking is not the focus of Basic Education. There is the Programming and Robotics project, but it is not easy to insert this at this stage; but I recognize the importance of Mathematics in programming, not only in binary language. Conditional programming, like in Scratch, allows students to be more autonomous.* (PP1)

*I do not work with approaches that involve the development of Computational Thinking.* (PP2)

Brazilian professors highlighted perspectives on the Computational Thinking approach. One of them had already signaled the use of digital technologies in robotics workshops in a mathematical context in elementary school, in addition to involving them in Arts and virtual reality. The other teacher pointed out an example of a website that approaches computer programming in a playful way in subjects outside the formal regency of Mathematics.

Only one of the Portuguese professors took a position on the development of Computational Thinking. Her speech highlights the difficulty of approaching computational thinking in Basic Education, where it is possible for students to develop ideas, not artifacts (WING, 2006), in autonomous processes, such as using the Scratch language. However, she recognizes its importance (CSTA; ISTE, 2011) in curricular proposals for this teaching stage (BARCELOS et al., 2015).

The teacher also reports the existence of a Robotics Project in her school environment. It serves to debunk some myths, such as: that programming is only for scientists and professional programmers or that resources, such as robotics, are not useful or possible to teach curriculum content. Including robotics in educational environments, as a source of production of learning principles in Basic Education, can serve to motivate students to develop new knowledge (not just curriculum), in addition to making the school environment more attractive (MAFRA et al., 2017).

6 Results

The analysis of the speeches showed, from the adopted categories, that there are connections between digital technologies and the adopted categories, according to the reports of Brazilian teachers (PB1 and PB2) and Portuguese teachers interviewed (PP1 and PP2).
Table 3 presents the synthesis of the comparison of the discourses of teachers from the two countries regarding the acts of curricula and views on the reforms of recent curricular documents, highlighting similarities and specificities, regarding the adoption of Digital Technologies:

Quadro 3: Similaridades e especificidades dos discursos dos docentes brasileiros e portugueses no que tange visões e práticas nos contextos de reformas curriculares recentes nos países.

<table>
<thead>
<tr>
<th>CATEGORIES</th>
<th>SIMILARITIES</th>
<th>SPECIFICITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Attitude towards Mathematics.</td>
<td>They recognized that the strategic use of digital technologies strengthens the teaching and learning processes of the current generation and can come to support the learning of mathematical procedures in connection with reality.</td>
<td>A problem situation involving mobile device memories was illustrated, using terms that refer to technology and introducing mathematics as a cause and not a consequence of such an approach to resources.</td>
</tr>
<tr>
<td>(2) Calculator use</td>
<td>They were resistant to the recommendation on the use of calculators in the BNCC, one highlighting the need to use pencil and paper and the other classifying the resource only as an account accelerator, emphasizing the development of mathematical reasoning.</td>
<td>They signaled the setback in the reform introduced by PMCMEB (2013), by emphasizing that the calculator should only be adopted in teaching situations in the most advanced years, refuting what such a perspective represents and that it should be adopted with an exploratory character since the early years of schooling. Exemplification of approach using technologies in the variation of parameters in the teaching of Functions and the emphasis on oral communication in an exploratory character from the use of graphing calculators.</td>
</tr>
<tr>
<td>(3) Digital Literacy</td>
<td>They assumed that technologies promote protagonism in the teaching of Mathematics.</td>
<td>They reinforced that the adoption of technologies requires new attitudes from teachers in the didactic situations proposed in Mathematics classes.</td>
</tr>
<tr>
<td>(4) Non-mathematical contexts</td>
<td>The connection between art and virtual reality in non-mathematical contexts was emphasized, with emphasis on the use of technologies in the thematic unit Statistics, optimizing the approach of the graphic part and the work with animation and solid planning in the unit Geometry. The use of technologies during the Life Project and Directed Study classes.</td>
<td>They adopt digital technologies within the scope of Flexibility in non-mathematical contexts in the fields of Geometry, Functions and Data Processing and use of technologies in purely mathematical contexts.</td>
</tr>
<tr>
<td>(5) Computational Thinking</td>
<td>They reported the existence of Robotics workshops in the school context, even with all the challenges and difficulties of approach in Basic Education.</td>
<td>They highlighted the implementation of robotics workshops, primarily in mathematical contexts and the existence of a playful website that deals with programming.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The potential of programming in Scratch language and the existence of a Robotics project were reported. They pointed out that the project can serve to motivate and build new curricular and extracurricular knowledge by students.</td>
</tr>
</tbody>
</table>

Source: Research Data.

The comparative analysis of the discourses of Brazilian and Portuguese
teachers showed similarities and dissonances between their curriculum acts in Basic Education regarding the use of Digital Technologies, literature and the perspectives prescribed in recent Mathematics curricular documents in the countries.

7 Final Considerations

The discourse of Brazilian and Portuguese teachers reinforced that the strategic use of digital technologies (DICK; HOLLEBRANDS, 2011) strengthens the teaching and learning processes of the current technological generation, fostering learning and procedures, as well as the development of advanced skills. These skills promote the construction of new knowledge (MARTIN, 2006), which may lead to positive attitudes towards the area of Mathematics.

The reports of Brazilian teachers showed resistance to the adoption of calculators, one of them highlighting the need to use pencil and paper and the other classified the resource only as an accounts accelerator, emphasizing the development of mathematical reasoning. However, dissonances were detected in the speeches due to the fact that one of them highlighted that the tool can be adopted in a moderate and correct way, but without specifying the typology of didactic situations in which such a resource would be relevant and promising. Then, there was a dissonance in the discourse of a Brazilian teacher, referring to the demands for knowledge about new technologies, which result in the adoption of new teaching attitudes towards technologies. The teacher exemplified a didactic situation in which he brought the combination of the calculator and the computer, adopted as combined resources, in the thematic unit Probability and Statistics.

On the other hand, the speeches of the two Portuguese teachers pointed out that the PMCM E (2013) was configured as a setback in recommending the calculator in teaching situations in the most advanced years. They reported the need to approach this perspective since the early years, as it would provide dynamics in the connections and approaches of various contents of the curriculum.

One of the Brazilian professors highlighted a competence on Digital Literacy perspectives prescribed in the BNCC. He made explicit the need for teaching leadership in the face of the use of digital technologies, which have come to occupy a central role in teaching processes. The speeches of Portuguese teachers also elucidated that the most recent Mathematics curriculum reform that took place in the
country, through the AE document (MEC, 2018), prioritizes the active participation of students with the use of digital technologies. It brings principles about Digital Literacy in mathematical and non-mathematical contexts through curricular flexibility, configuring a resumption of this methodological perspective when referring to the 2007 Mathematics Program.

The analyzes also made it possible to demonstrate the importance of using digital technologies in connection with the reality of students to foster positive and responsible attitudes in the usability process for the construction of new knowledge, as clearly indicated in the teachers’ speeches (PB1 and PP1).

The speeches of teachers from both countries also highlighted the complexity of proposing didactic situations that promote the development of Computational Thinking in Basic Education. Its relevance in contemporary curricular reforms is highlighted as it allows students to generate ideas, not artifacts, in processes that should prioritize the development of their autonomy. Thus, in the discourse of a teacher from each country, perspectives related to the Multidisciplinary Robotics Project in the school context emerge.

In the process of being finalized, it is highlighted that the analysis of the discourses of Brazilian and Portuguese teachers showed similarities and dissonances between their curriculum acts in Basic Education and their discourses regarding the use of digital technologies, literature and the perspectives prescribed in the most recent mathematics curriculum documents in force in their countries.

The investigation allowed us to reinforce the focus of the skills and competences contained in the current curricular guidelines, in both countries, in the performance models (BALL, 2010), which is configured as a global trend of management and control regarding the intentions of contemporary curricular reforms.

In this sense, the case study clarified the need for continuous discussion on the emphasis given to digital literacy in recent curricular reforms and on the approach of interdisciplinarity within the scope of specific disciplines that deal with the use of Technology and Information in contexts of mathematical and non-mathematical practices. It also confirms the need to focus on research and connections between Mathematics and Computational Thinking in Basic Education so that various practices are fostered in integrative projects that develop students’ autonomy and creative process (MAFRA et al., 2017).
It should be noted that both perspectives are part of the Mathematics 2030 Project managed by the OECD, a relevant entity with an interest in implementing curricular reforms around the world. This indicates to the business world which countries are complying with guidelines in areas such as Education and Economy, signaling locations for investments by private companies that aim for skilled labor according to their established neoliberal standards.

References


Paulo.


JENKINS, Henry; Purusotma, Ravi; WEIGEL, Margaret; Clinton, Katie; ROBISON, Alice J. *Confronting the challenges of participatory culture*: Media education for the 21st century. Cambridge, MA: MIT Press, 2009.


