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Brazilian Technology Policies in Education: History and Lessons Learned[1]

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Abstract: Brazilian initiatives aimed at the insertion of information and communication technologies (ICT) in K-12 education took their first steps in the 1970s, when several countries focused their efforts on the use of ICT in the educational context. Since the early 1980s, a number of public policies have been created that have given rise to various projects and programs developed at the national level. The objective of the article is to analyze these policies using the Four in Balance model resignified for the Brazilian reality. The methodology is based on a study of documents. The EDUCOM Project, the Immediate Action Program in Informatics in Education, and the national programs, PRONINFE and ProInfo, were analyzed. The results show that these projects and

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programs did not always balance the axes of vision, teacher and manager training, digital educational resources and infrastructure, and cross-curricular evaluation and research. From this analysis it was possible to highlight some lessons and suggestions for future public policies related to the implementation of technologies in education.
Keywords: Public policy; educational technology; informatics in education; basic education; ICT; Four in Balance

Políticas de tecnologia na educação no Brasil: Visão histórica e lições aprendidas
Resumo: As iniciativas brasileiras voltadas à inserção das tecnologias de informação e comunicação (TIC) na educação básica deram seus primeiros passos na década de 1970, período em que diversos países direcionaram esforços na realização de atividades orientadas para o uso das TIC no contexto educacional. Desde o início dos anos 1980 foram criadas políticas públicas das quais se originaram vários projetos e programas desenvolvidos no âmbito nacional. O objetivo do artigo é analisar essas políticas utilizando o modelo *Four in Balance* ressignificado para a realidade brasileira. A metodologia é baseada em um estudo documental. Foram analisados o Projeto EDUCOM, o Programa de Ação Imediata em Informática na Educação e os programas nacionais, PRONINFE e ProInfo. Os resultados mostram que esses projetos e programas nem sempre apresentaram de forma equilibrada os eixos visão, formação de professores e gestores, recursos educacionais digitais, infraestrutura e o eixo transversal currículo, avaliação e pesquisa. Dessa análise foi possível destacar algumas lições e sugestões para futuras políticas públicas sobre a implantação das tecnologias na educação.
Palavras-chave: Políticas públicas; tecnologia educacional; informática na educação; ensino básico; TIC; *Four in Balance*

Políticas tecnológicas en educación en Brasil: Visión histórica y lecciones aprendidas
Resumen: Las iniciativas brasileñas destinadas a la inserción de las tecnologías de la información y la comunicación (TIC) en la educación básica dieron sus primeros pasos en la década de 1970, un período en el que varios países dirigieron sus esfuerzos para llevar a cabo actividades orientadas al uso de las TIC en el contexto educativo. Desde principios de la década de 1980, se han creado políticas públicas a partir de las cuales se han originado varios proyectos y programas desarrollados a nivel nacional. El objetivo del artículo es analizar estas políticas utilizando el modelo Four in Balance reformulado para la realidad brasileña. La metodología se basa en un estudio documental. Se analizaron el Proyecto EDUCOM, el Programa de Acción Inmediata en Informática en Educación y los programas nacionales, PRONINFE y ProInfo. Los resultados muestran que estos proyectos y programas no siempre presentaron, de manera equilibrada, los ejes de visión, la formación de docentes y directivos, los recursos educativos digitales, la infraestructura y el eje transversal del currículo, la evaluación y la investigación. A partir de este análisis, fue posible resaltar algunas lecciones y sugerencias para futuras políticas públicas sobre la implementación de tecnologías en la educación.
Palabras-clave: Políticas públicas; tecnología educativa; informática en educación; educación básica; TIC; *Four in Balance*

Introduction[2]

The use of computers in education in Brazil began with a couple of experiences in universities, in the beginning of the 1970's, motivated by what was taking place in other countries such as the Unites States and France (Valente & Almeida, 1997).

For example, at the Federal University of Rio de Janeiro (*Universidade Federal do Rio de Janeiro* - UFRJ), in 1973, the Nucleus for Educational Technology for Health (*Núcleo de Tecnologia Educacional para a Saúde* – NUTES) and the Latin-American Center for Educational Technology (*Centro Latino-Americano de Tecnologia Educacional* - CLATES) utilized computers to teach chemistry, making use of simulators. During this same year, various experiences simulating phenomena in physics were carried out with college students at the Federal University of Rio Grande do Sul (*Universidade Federal do Rio Grande do Sul* - UFRGS). In addition, the Center for Data Processing (*Centro de Processamento de Dados*) developed the SISCAI software to evaluate postgraduate student in the department of Education. At the State University of Campinas (*Universidade Estadual de Campinas* - UNICAMP), in 1974, software such as CAI (Computer Aid Instruction) was developed for teaching key aspects of the BASIC programming language. In 1975, the document "Introduction to Computers in High-School Education" (*Introdução de Computadores no Ensino do 2° Grau*) was produced, financed by the Program for the Reformulation of Education (*Programa de Reformulação do Ensino* – PREMEN) of the Ministry of Education (*Ministério da Educação* - MEC). In addition, during this same year, Seymour Papert and Marvin Minsky first visited Brazil. They were responsible for disseminating the first ideas for the use of Logo at UNICAMP.

However, initiatives aimed at the inclusion of information and communication technologies (ICT)[3] in K12 education took place during the beginning of the 1980s, based on the enactment of public policies by institutions of the federal government, particularly by the Ministry of Education (*Ministerio da Educação* - MEC). The idea for the elaboration of the first public policy at a national level took place during the First National Seminar on Informatics in Education (*I Seminário Nacional de Informática em Educação*), at the University of Brasilia in August of 1981. During this seminar the first idea for the establishment of pilot-projects in universities came about, where investigations with an experimental nature would take place and would serve as a basis for a future National Policy for the Computerization of Education (*Política Nacional de Informatização da Educação*; Moraes, 1997). In December of 1981 the document "Subsidies for the Establishment of the Program for Informatics in Education" (*Subsídios para a Implantação do Programa de Informática na Educação*) was approved, co-signed by MEC, the Special Department for Informatics (*Secretaria Especial de Informática* - SEI) and the National Council for Scientific Development (*Conselho Nacional de Desenvolvimento Científico* - CNPq). In order to strengthen the ideas for activities to be applied in the pilot projects, a Second

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[3] According to Buckingham (2003), media is both a tool and a medium that carries information represented by multiple language modalities (oral, written, images, hypermedia…) as well as technological resources (computer, tablet, iPad, cellphone...). Further, Vieira Pinto (2005) considers that technique is an act of creative and intentional production at the heart of social relationships in a given culture, demonstrating a critical understanding of technique and knowledge of technology. Therefore, technique is a mediator of actions and relationships amongst men that constitute themselves through its production, and transform it during the processes of production and appropriation. For a deeper study of the relationship between technology and education in public policies, we consider that it is important to assume that information and communication technologies (ICT) are instruments of a given culture, that interrelate technological, media, and language devices, and that the appropriation of these devices have implicit political dimensions.

National Seminar for Informatics in Education (*II Seminário Nacional de Informática em Educação*) took place at the Federal University of Bahia (*Universidade Federal da Bahia*) in August of 1982. Therefore, these seminars served as a basis to launch the document for the EDUCOM Project in 1983, which introduces the project proposal for the field of technology in education (Andrade & Albuquerque Lima, 1993).

Based on the EDUCOM Project, a series of other projects and programs were proposed as part of public policies for digital technology in education in Brazil. These included the National Program for Educational Informatics (*Programa Nacional de Informática Educativa* - PRONINFE) and the National Program for Informatics in Education (*Programa Nacional de Informática na Educação* - ProInfo). Analyzing these public policies' proposals, one can observe that they were implemented through projects, action plans, and national programs that vary in scope, in the logistical and financial support they received from different administrative federal institutions, as well as in the provision of resources for the establishment and maintenance of the activities.

Since the 1980s, education is considered one of the pillars for policies targeted at the population's digital inclusion, which took place through financial incentives for research, professional development, and programs for the incorporation of technological devices, the establishment of infrastructure in schools, connection to the Internet, and teacher training. However, the impetus observed in the process of appropriation of ICT in sectors for productivity, telecommunication, and scientific development does not meet the same vigor in the various levels of the educational systems, nor in schools.

To this day, Brazilian education faces basic dilemmas when considering the appropriation of ICT. On the one hand, at the administrative level, the activities executed in education concerning the use of ICT are developed through systems of management, logistics, and distribution of questions concerning the use of of time and space, teacher allocation, and academic control. On the other hand, the use of technology in the classroom still rouses dilemmas as to whether educators should use ICT in the teaching and learning processes or not, as can be seen in studies such as Cysneiros (1995), Axt (2000), Almeida (2014), and Almeida e Valente (2016). In cases in which ICT are used, one can observe that the activities provide for significant results (Valente & Almeida, 2018), difficulties, and challenges of varying nature, which are very common to the reality faced in other countries (Costa, 2004; Liu & Huang, 2005; Vanderlinde, Aesaert & Van Braak 2015), but that become more decisive due to the Brazil's continental scale, socioeconomic inequalities, and regional differences.

Therefore, this article is based on a research project with a broader scope produced for the Center for Innovation in Brazilian Education (*Centro de Inovação para a Educação Brasileira* - CIEB; Almeida & Valente, 2016), deepening critical analysis in relation to theory. The article's objective is to describe and analyze the essential elements present in the projects, programs, and policies for educational technologies at a national level, which include: connectivity, infrastructure, pedagogic use of ICT (including software), teacher training for the use of media and technology, the inclusion of digital technology abilities in school curricula, access to digital content and resources, and the participation and vision of administrators in different spheres of the educational system.

The documental information and the analysis that make up this paper are the result of other research projects by the authors (Almeida, 2019; Almeida & Valente, 2016; Valente, 2005), over twenty-five years of research advising, and consultant work for the creation of public policies for technology in education at the Brazilian federal, state and municipal levels, all of which allows for us to gather significant knowledge of the theme. Attention to the complex problems made evident in different context and temporal periods, combined with the production of knowledge on the theme, makes it possible for the development of acute reflection as to the relevant elements that exist in

initiatives that derive from policies for educational technology, the production of new knowledge and the recognition of lessons learned. These can support new studied and policies that consider different aspects that compose and broaden this complex problem faced with recent progress in digital culture.

Therefore, this article is organized as follows: introduction of the *Four in Balance* model that guides the analysis of public policies related to the use of ICT in education, resignified to a Brazilian reality; synthesis of the main programs, policies and initiatives by the Brazilian government, from MEC and other institutions; and a systematization of the main lessons learned during the establishment of these policies, programs, and national initiatives. The objective of this piece is to analyze public policies for the use of ICT in education that were implemented in Brazil and that can contribute to further advances in the Brazilian context, and serve as a reference to other countries of lessons learned.

Conceptual Basis for Our Analysis – The *Four in Balance* Model Resignified to the Brazilian Reality

An analysis of the implemented policies, programs, and projects related to ICT in education set forth in a couple of countries indicates that the main concern is centered on infrastructure and content, closely followed by vision, competency, not considering aspects related to curricula, evaluation, and research (Almeida & Valente, 2016). Although these are a constant concern of educational practices mediated by ICT, only now do we see methodologies that systematize into procedures the theoretical references that explicitly discuss the balance between infrastructure, content, vision, and competence, as in the *Four in Balance* model.

The *Four in Balance* model was developed in 2001 by the ICT for Schools Foundation, from the Netherlands (Stichting Ict op School, 2001). Currently known as the Kennisnet Foundation (Kennisnet, 2016), this is a public organization for Education and ICT, financed by the Ministry of Education, Culture and Science in the Netherlands. The *Four in Balance* model has been used for the development and evaluation of educational situations, aiming to effectively and efficiently use ICT in education. This model is composed of two elements, human and technological. The human element is composed of two axes: **vision** and **competence**, while the technological element contains axes for **digital content and resource** and for **infrastructure**.

According to the Kennisnet model (2015), the four axes must be in equilibrium in order for the use of ICT to be effective, guided, and controlled. In order to do so, it is the responsibility of public officials to guarantee that schools have the conditions to conceive of pedagogic projects that are adequate to their reality, considering the educational purposes and the community's expectations. This allows for teachers to structure the teaching and learning process more efficiently, and for schools to better transparency of school activities to parents and society. Though this model is important to understand both the existence of all four axes, as well as their interdependence, the resignification of this model must consider both the concrete conditions of Brazilian reality, as well as the conceptions, values, and beliefs underlying the schools' pedagogical practices.

An understanding of the *Four in Balance* model and the proposal for its resignification to a Brazilian reality requires an interpretation of the four axes according to the characteristics and specificities of its educational system, re-establishment of equilibrium amongst the axes, and the development of a transversal axis comprised of curriculum, evaluation and research. This requires that new meaning be given to the ideas implicit in each of the axes predicted in the original model (Kennisnet, 2016) and in the specification of the components of the transversal axis, which is constituted based on knowledge of public policies regarding ICT in education in Brazil (Almeida,

2014; Andrade & Albuquerque Lima, 1993; Valente & Almeida, 1997). This resignification of the model also leads to the reinterpretation of the vertical axes (vision, competencies, content and resources, and infrastructure), which make up the *Four in Balance* model for integrating ICT in schools within the scope of the structures that make up the Brazilian educational system.

Axis Vision of the ICT

The effective use of ICT begins with the institution's clear vision of education, of didactics, of the goals for the use of ICT in these areas, and of leadership's role for this vision to become a reality. Therefore, vision is comprised of: a clear definition of how the educational system and the institutions of education conceive of a qualitatively solid and efficient education, and what is the role of ICT to achieve this; and a clear specification of the institution's basic objectives, including the necessary condition to achieve these objectives, considering beliefs regarding student's and teacher's roles, the selection of goals and materials, and the administrators' role.

This vision must be a shared by all the actors involved in the educational process in each of the system's spheres, which demonstrates the importance of public policies being integrated into the various sectors of governance (education, communication, science, technology, etc.) and in conversation with different spheres of public administration and with the school.

The axis vision must be broadened according to the perspective of concentric structures, using an ecologic framework of systems, which gives room to diversity, partnership, and change in practices (Pinazza, 2014), and involves values, beliefs and ideas. According to Brazilian reality, it is important to consider all layers that make up the educational system, such as the school, the Nucleus for Educational Technology (*Núcleos de Tecnologia Educacional* - NTE) in Brazilian states and municipalities, the school boards, the secretary of education, national policies, and the Ministry of Education and its related institutions.

Therefore, the axis vision encompasses national policies, the general formative processes expected in the country's education, its purpose, the role of ICT in these processes, and the attributions of the structures involved in the creation of the necessary conditions for development and learning, for comprehensive training, the practice of citizenship, and preparation for the work force.

Axis ICT Competencies

This axis includes the knowledge and abilities for the use of ICT as a teaching tool to support learning situations. Currently, due to the social dissemination of the use of ICT and of online social networks, most teachers demonstrate competency for the personal use of ICT. However, both teachers, and directors and specialists that provide support for the use of ICT in schools do not demonstrate to be conscious of ICT's educational potential. This occurs for various reasons, both related to the lack of understanding about the contributions of ICT, as well as to the lack of adequate resources and time for teachers' training. Therefore, the axis envisions the teachers', school directors', and supporting staff's competencies in ICT, and ensuring them with the responsibility to create the conditions for students to develop the appropriate digital competencies for their learning process.

Concerning the use of ICT in teaching and learning practices, the difference between competencies for using ICT and competencies for the didactic use of ICT is emphasized. The latter involves knowing when, how, and why to use ICT. Considering that competency is defined as the ability to take effective action when faced with a complex situation that mobilizes different types of knowledge, resources, attitudes and schemas for action and evaluation (Perrenoud, 1999), the development of pedagogical competencies for the use of ICT has as a starting point pedagogical

practices' context. Here is it necessary that the teacher put different abilities into synergy, and integrate languages, tools, resources, and interfaces with technologic, pedagogic, and theoretical knowledge during the planning process, the implementation of the lesson, and during the process of reflecting on their practice, moments in which they are faced with unexpected situations.

Regarding the proposal of public policies for the use of ICT in education, it is important to consider the competencies of the people and sectors that make up the structures of the educational system, which includes leaders, professional working in the central and intermediary institutions, administration, teachers, employees, students and their families. It is fundamental that these professionals have technical competencies, and that they appropriate ICT's media languages and functionalities in order to carry out their roles and maintain a dialogue with other professionals. These professionals should help schools develop projects for the integration of ICT, such as what took place in the Nucleus for Educational Technology (*Núcleos de Tecnologia Educacional* – NTE) and the Nucleus for Municipal Educational Technology (*Núcleo de Tecnologia Educacional Municipal* - NTM), developed to be decentralized structures of the Ministry of Education, in Brazilian states and municipalities, for the establishment of policies, programs, and projects. In the case that participants do not have the expected competencies, leaders of these policies are required to carry out measures for the development of competencies related to digital fluency, and that they understand the specificity of pedagogical practices using ICT.

As for teachers, they must be offered the opportunity for the pedagogic appropriation of ICT so that they have the conditions to integrate these technologies into educational and learning processes, into the curricular enhancement, and into the evaluation and research of their own practices, making use of these according to their pedagogic conceptions and intentions, with the goal of catering to the students' developmental needs. With such competencies, teachers are able to analyze the contributions, the risks, and the implications of when and how to integrate ICT into practice, and into the school's pedagogic project.

It is fundamental to provide for the development of competencies regarding the use of ICT in the administrative staff and members of the school council so that schools have an action plan for the integration of ICT that relates infrastructure, physical and financial resources, and the provision of time and space in the school. In addition, in line with the Brazilian national Constitution, ICT must serve democratic and participative management, promote dialogue within the school community, and to relate the distinct dimensions (technical-administrative, political, and pedagogic) that compose educational activities. It is also part of the administrator's role to: lead the inclusion of ICT in the school's pedagogic project with objectives that are discussed, approved and monitored collectively by the school community; guide the inclusion of information into the educational system's academic bases, interpret and apply the information generated by these bases, and use them to evaluate the school, and in collective decision making processes; establish means for dialogue with the school community, and analyze problems in the school and community, making use of various resources including social media.

The competencies of specialists and administrators/leaders that are part of the school system's structure includes the ability to use ICT to achieve the educational system's broader objectives, interpret and manage information from data-bases, make qualified decisions, and propose educational policies that are in line with reality and based on an ample consultation of the participants in the other sectors that make up the system's structure.

The competencies expected from the researchers and universities in partnership with the schools concern the advancement of abilities to advise schools in their projects for the pedagogic integration of ICT, guide processes for professional improvement and educator's continued learning, lead communities of learning and practice with educators so that they may develop the

autonomy for self-training. The partnership between universities and researchers with the schools refers to the development of collaborative researches with educators and with the school based on concrete problems that emerge in the school context and in the educational system. Everyone is a subject of the investigation, participating in all the steps of this work. In addition, it is imperative to review training processes in order for the relationship between theory and practice to become an inherent aspect of continued training and initial teacher training, in light of the links between issues of space, time, and context that stem from the incorporation of media and ICT in educational processes (Valente & Almeida, 2014).

Digital Content and Resource Axis

In the *Four in Balance* model, the axis digital content and resources must include: digital material for learning produced for educational purposes and for general sources of information; educational software packages and ICT systems, such as virtual learning environments, a repository of the student's records and production, and a system for managing students' information; general office software and applications; software for controlling agendas; and tools for the managing human resources[4]. In addition, the model considers the relevance of didactic material, digital databases for online digital resources, games, applications, specific portals for educators and students, and other resources that offer potential to contributing to student learning.

The selection of specific educational software has a growing impact on the structure and organization of school learning. Administrators and teachers must have the ability to obtain information on the available software and their content, as well as know how to make a responsible choice, according to the school's educational mission, and the different teaching methodologies that make up the teachers' preferences, considering, primarily, the student's characteristics, interests, conditions and the needs for learning.

This demonstrates that the use of ICT in Education is not neutral. The application of ICT intended to support learning implicates in the need for objectives and ideas that go beyond the use of software for exercises and practice. Teaching through the use of ICT must integrate these technologies into the curriculum, and this use must be in line with the school's educational mission.

The integration ICT into the pedagogic project and teacher's practice occurs according to intentions and objectives that are in line with the school's pedagogic project, which demonstrate underlying ideas about teaching, learning, curriculum, and evaluation. Simultaneously, in Brazil there are different visions regarding the integration of ICT into education (Valente, Freire & Arantes, 2018), each with underlying curricular proposals for the educational system (the lack of ICT also demonstrates a certain vision), which are ressignified and transformed when the teacher elaborates their work project. Therefore, it is important to allow for the teacher to develop competencies for analyzing the characteristics, limits, and potentials of technological tools and interfaces, of digital content, and of available resources.

These digital content and resources that enter school environments and interfere in classroom practices are expanding through the use of mobile technologies with wireless connection to the Internet (Almeida & Prado, 2011; Sampaio & Elia, 2012; Valente, Baranauskas & Martins, 2014). These are intensely used by the majority of students (Núcleo de Informação e Coordenação do Ponto BR, 2019) and spark the need to review the school's structure, organization, and functioning, as well as the need for an opening of curriculum to integrate updated information from the web, discuss with specialists outside of the school environment, and produce and share

[4] The *Four in Balance* model does not refer to resources on online social networks. However, these are considered in the resignification of the model to a Brazilian reality, as we address in this analytical topic.

knowledge that is represented through the use of media languages. As Almeida and Prado (2011) revealed, this situation demonstrates the importance of competencies in the school staff (administration, teachers, and other professionals) in order to identify available content on the web and in other digital didactic materials, and for the contextualized evaluation of these resources according to the schools' educational mission and the pedagogic objectives of classroom activities (Almeida & Silva, 2014).

Axis Infrastructure

According to the *Four in Balance* model, the use of ICT in schools requires adequate technological infrastructure. Each school must install technological resources according to its reality, needs and options, and must also consider if the school opts to buy computers or use the devices students' carry and can bring to school. Therefore, the axis infrastructure must also contemplate: the availability and quality of hardware, web and connectivity within the educational system and within the institution, including governance and management of ICT; and the establishment, management, and maintenance of the technological infrastructure and support for the use of ICT.

The axis infrastructure aims to provide the physical infrastructure, high speed broadband connection, distribution of Internet throughout the school spaces, and equipment for administrative and pedagogic use, that will provide the conditions for accessing digital educational content and tools for processing information, and the development of knowledge, communication, and collaboration. This demands a logistic for the distribution, installation, replacement, updating, continuous monitoring, and maintenance through the means of a system for managing resources for network, connectivity, hardware and software, and which should consider the schools' autonomy, its pedagogic project, and work options.

The concrete possibilities of Brazilian schools, associated with the country's territorial dimension make the implementation of infrastructure and complex and expensive task. These challenges weaken the school's adequate infrastructure, and compromise the success of policies, as will be addressed in the following topic.

Transversal Axis: Curriculum, Evaluation and Research

The curricular policies, guidelines, and proposals are an option, amongst other possibilities, taken on by society and its representatives, according to a selection and planning logic. An educational system's curricular proposal is (re)developed during the elaboration of a school's pedagogic project, of the teachers' work plan and in their pedagogic practices. Thus, pedagogic practice encompasses the content, methods, procedures, and activities (Sacristan, 1998) employed during the effective work exchange between teachers and students, in which scientific knowledge, symbolic and cultural elements, know-how of the teaching practice, the students' previous knowledge, social communication practices, and techniques and artifacts are involved. According to this perspective, the curricular proposal is united to digital culture curriculum, which demands new teaching dynamics and strategies, different research and evaluation methodologies, indicating the importance of establishing relationships between ICT, the curricula, evaluation, and research. Therefore, we envisaged the inclusion of a fifth axis that is transversal to the four proposed in the *Four in Balance* model, which is constituted of curriculum, evaluation, and research.

Almeida (2010) stresses that ICT, when integrated into the teaching and learning process, and into curriculum and evaluation, lead to specific contributions due to the characteristics inherent to these technologies, such as language for communicating and representing thoughts through a variety of languages, and multiple genres, and medias.

Information and communication technologies are symbolic instruments of culture that structure thinking, the processes of representation, attribution and negotiation of meanings,

therefore also structuring curriculum, allowing for the hybridism (Canclini, 2011) between diverse cultures (academic, digital, from minorities, etc.). Simultaneously, curriculum constitutes itself as a product of the cultures with which it is interrelated. Therefore, the combination of technology and curriculum is inherent to the digital culture emerging in society and is transversal to the curricular components, not restricting itself to the development of specific disciplines. In the networks of knowledge and meaning, technology, languages, and areas of knowledge converge and interconnect.

Through network connections, it is possible to integrate formal educational spaces with other spaces of knowledge production, favoring integration into non-formal educational spaces, such as museums, exhibits, libraries, and virtual laboratories, and informal educational spaces such as bookstores, parks, and gardens, thus creating hybridity (Ackermann, 2013) between educational and social spaces. Therefore, it is possible to integrate the school with a digital culture emergent in society, and to create a digital culture in the school (Iannone, Almeida & Valente, 2016).

On the other hand, ideas regarding evaluation are at the heart of the understanding of the curriculum, which underlies the distinct dimensions of evaluation, be it of learning or teachers, courses, institutions, systems, etc. Therefore, evaluation of learning can either limit itself to verifying the content memorized, demonstrated through exams and tests, or can be related to the monitoring or guiding of the student's learning.

When evaluation is conceived as inherent to the learning process (Hernandéz, 1998), it takes on a formative aspect (Hadji, 2001). In order to do so, the teacher must make use of mechanisms for registering and storing, of search engines and information retrieval to monitor the accomplishment of pedagogic activities, the learning processes, and student production, giving students the chance to self-evaluate and regulate their own learning process.

Given these ideas regarding curriculum and evaluation, it is possible to take on a research approach that overcomes the dichotomy between the university and schools, with the development of spaces for interaction, reflection, and co-production between the academic researcher and the teacher responsible for what takes place in the classroom. This research is developed in the school with school subjects, rather than being about the school or a given teacher.

In this sense, research can have as participating subjects the director, teacher, and students, as well as the professionals in intermediate or central levels of the educational system. Research with teachers and other professionals in education has as its focus the possibility of reflecting on one's own practices (Schön, 1992), considered reflective professionals (Zeichener, 1993). The teacher or other professional in education reflects on their practice, which the teachers themselves problematized and criticizes, and is urged to identify their limits, possibilities, points for improvement, and proposals for changes (Martínez Bonafé, 1999).

The transversal axis, made up of the triad curriculum, evaluation, and research, monitors and can offer support for the search for a balance between the four axes (vision, competencies, content and digital resources, and infrastructure), which makes up the *Four in Balance* model for Brazilian reality, as well as receives feedback from the other four, in a circular and ascending spiraling perspective, as seen in Figure 1. In order to implement ICT in education, according to the *Four in Balance* model, all four axes need to be in equilibrium, represented through their imbrication. The transversal axis, curriculum, evaluation, and research, is represented by arrows that circulate around all four axes, so that their continuous action allow for the construction of knowledge in the form of an ascending spiral (Valente, 2005), providing feedback to the fours axes, as well as the transversal axis itself.

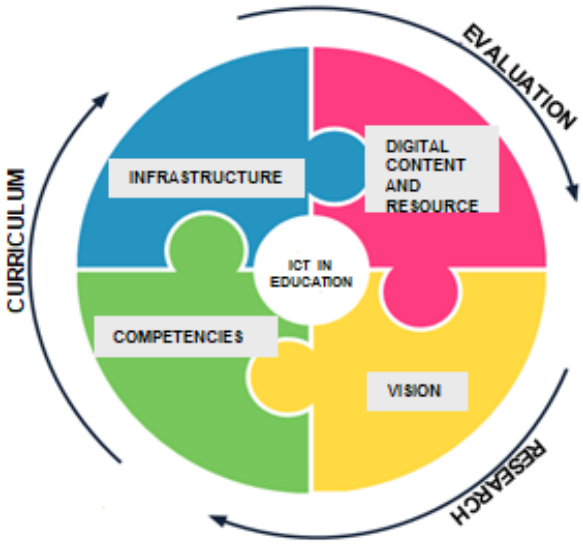

Figure 1. The four axes in balance, with a circular and continuous feedback by the transversal axis. Source: adapted from Almeida and Valente (2016, p. 35).

The fours axes in the model are important for the implementation of policies for ICT in education. However, though these axes might be in balance in a given reality, they represent the instrumental aspects inherent to the realization of actions. The transversal axis is responsible for creating the amalgam between the four axes, and the intentions of both the subjects and the institutions that make up the different layers of the educational system, requiring one to question why, how, who, and for whom to carry out policies for technology in education (Freire, 1995).

Analysis of Brazilian Policies, Projects and Programs

MEC's initiatives, grossly speaking, begin with specific projects through which the process of consolidation leads to program proposals and to the elaboration of broader public policies. In general the projects are occasional and of interest to different federal administrative agencies. For example, the EDUCOM Project was created thanks to the Special Informatics Department's (*Secretaria Especial de Informática* – SEI) interest. This department is part an executive office in the President of the Republic's (Presidência da República - PR) Council for National Security (*Conselho de Segurança Nacional* - CSN), whose objective was to regulate, supervise, and foment of the informatics sector (Andrade & Albuquerque Lima, 1993). SEI, the agency responsible for the coordination and execution of the National Informatics Public Policy (*Política Nacional de Informática*) aimed to

> (…) foment and stimulate the informatization of the Brazilian society, focused on scientific and technological training that is capable of promoting national autonomy, based on principles and guidelines grounded on Brazilian reality and a result of research activities and the consolidation of the national industry. (Moraes, 1997, n.p.)

However, to achieve these goals it was necessary to establish measures for digital technology in various segments of society, such as education, engineering, health, agriculture, culture, and national defense, given that there was a consensus amongst SEI/CSN/PR that education would be the most important sector for the development of an acceptable modernity that was unique to the country.

In order to execute these actions, national programs were instituted through regulations with their own budget allocation. As an example one can see the Immediate Action Program for

Informatics in Education (*Programa de Ação Imediata em Informática na Educação*) that made the EDUCOM Project possible; the National Program for Educational Informatics (*Programa Nacional de Informática Educativa* - PRONINFE); and the National Program for Informatics in Education (*Programa Nacional de Informática na Educação* - ProInfo).

In the following topics the EDUCOM Project, the Immediate Action Program for Informatics in Education, and the national programs PRONINFE and ProInfo are presented, discussed, and analyzed in light of the *Four in Balance* model resignified according to Brazilian reality.

EDUCOM Project

The EDUCOM Project was approved in 1984 and established in 1985, coordinated by the Ministry of Education's Informatics Centre (*Centro de Informática - CENIFOR*), as a result of a protocol signed between MEC, SEI, CNPq, Financier for Innovation and Research (*Financiadora de Inovação e Pesquisa* – FINEP), and Foundation Brazilian Center for Educational Television (*Fundação Centro Brasileiro de Televisão Educativa* – FUNTEVÊ). The general objective was to stimulate interdisciplinary research focused on the use of digital technology in the teaching-learning process (Andrade & Albuquerque Lima, 1993).

The project's specific objectives were to establish Research and Development Nucleus for Informatics in Education *(Núcleos de Pesquisa e Desenvolvimento de Informática na Educação*) and Pilot-centers for Informatics in Education (*Centros-piloto de Informática e Educação*), to train human resources involved in the establishment and implementation of the EDUCOM Project, the monitoring and evaluation of the experiences, and the dissemination of results.

Implementation of the EDUCOM Project. Since the beginning of discussions regarding the establishment of measures for digital technology in education, the community of researchers decided that the policies that would be established should always be based on research that was in line with concrete experiences in the public school context, primarily at high-school level. Therefore, universities and research centers were encouraged to submit proposals for the development of pilot-centers. Of the 26 proposals received, five were chosen to receive such research centers, each one embracing a research focus: the Federal University of Rio Grande do Sul *(Universidade Federal do Rio Grande do SUL* - UFRGS) dedicated itself to the development of projects and activities related to computational systems and human resource training, to students' cognitive and emotional development through the use of computers, and micro-worlds in the scope of the Logo programing language; the State University of Campinas (*Universidade Estadual de Campinas* - UNICAMP) developed measures based on the Logo programming language for the use of computers during teaching and learning processes, which was carried out in three public schools in the Campinas region; the Federal University of Rio de Janeiro (*Universidade Federal do Rio de Janeiro* - UFRJ) developed hardware, software, and courseware (simulation type), and prepared professionals for the development of courseware, as well as for the use of computers in schools; the Federal University of Minas Gerais (*Universidade Federal de Minas Gerais* - UFMG) carried out actions centered on the development and study of teaching programs aided by the computer, particularly at the high-school level; the Federal University of Pernambuco (*Universidade Federal de Pernambuco* - UFPE) carried out actions in three areas, development of methodologies for the implementation of educational software (mathematics in K12 Education), development of a local network at a low cost, and the study of the socio-cultural aspects and the sociopolitical impacts of the use of computers in education. Therefore, the EDUCOM Project was established based on the activities and research carried out by these five universities.

In terms of methodology, the task was executed by interdisciplinary teams made-up of teachers from the chosen schools, and by a group of professionals from the universities participating

in EDUCOM. The teachers from the schools were responsible for the development of pedagogical activities, with the support and monitoring of research groups from these universities, composed of educators, psychologists, sociologists, and computer scientists. These activities had the objective of contributing to the development of the research project, as well as the training of these professionals from schools and research centers.

From the technological point of view, the role of the establishment of computers in schools was to help to provoke pedagogic changes, rather than "automate teaching" or prepare students to be capable of working with a computer. All of the research centers for the EDUCOM Project acted on the premise of creating learning environments using the computer as a resource that would mediate the learning and teaching process. The biggest challenge was a change in the educational approach: transform education based on the transmission of information into education where students could carry out activities through the use of computers, and thus create possibilities for the development of knowledge. The research training in these centers, the training activities developed, and even the educational software created by a few centers were elaborated based on the possibility of this sort of pedagogic change.

Main results. The EDUCOM Project ended in 1991. During the six years (1985-1991) of its development, the work executed in the pilot-centers had the merit of elevating digital technology in education from practically null to a state in which the interdisciplinary teams started to understand and discuss large issues in this area of study. The experiences carried out in Brazil present positive results and some evidence of pedagogic change (Andrade, 1993; Andrade & Albuquerque Lima, 1993; Moraes, 1997). However, they were not sustained due to the fact that they were submitted to the conditions for these changes to be developed in the educational system as a whole: a change in school organization and classes in the computer lab, which should have been integrated with activities in the classroom, changes in the teacher's and students' role, and in the relationship between the student and knowledge.

Thus, in addition to the establishment of five pilot-centers, the research carried out using different approaches to digital technologies in education, the EDUCOM Project allowed for the creation and consolidation of a national culture for digital technology in education, based on the reality of Brazilian public schools, and for training for researchers in universities and a few teachers in the participating public schools.

Analysis of the EDUCOM Project activities according to the Four Axes in Balance model and the Transversal Axis. An analysis of the EDUCOM Project according to the *Four in Balance* model intended for Brazil is done according to the resignification of the four axes according to Brazilian reality and includes a transversal axis – curriculum, evaluation, and research - spanning the rest.

With regard to the axis vision, one can observe that this axis referred to computerizing the teaching and learning processes through the establishment of digital technology in education, based on results of research carried out by centers of academic excellence, taking into consideration the reality of participating Brazilian public schools.

In the axis competencies, training for professionals that acted in the pilot centers and in the research center was expected, as well as competencies developed by teachers and students in the participating schools. Many teachers began working in the universities' research centers, and students demonstrated competency in the development of projects with the use of a computer, particularly with regards to Logo Language, as described by Valente (1996).

One of the objectives of the EDUCOM Project was the development of digital content and resources. However, the little material that was produced quickly became inoperable due to changes

in the devices' configurations. What existed in terms of digital content and resources was restricted to the Logo Language for computers MSX and Itautec I7000, the I7000' Portuguese word processor, and programs for programmed instruction and educational games for Apple and MSX computers available at the time.

Infrastructure was very precarious, for Brazilian computers were still not technically robust and the computer industry was still in beginning its development. One can affirm that infrastructure was lacking from the onset of Brazilian public policy, compromising activities related to participating schools, as well as the balance between the four axes, as advocated for in the *Four in Balance* model.

With regard to the transversal axis – curriculum, evaluation and research – one can identify that a few curricular areas incorporated the use of computers in specific activities, particularly in the areas of mathematics and science, allowing for one to understanding what could have been done with digital technology in education and learning. However, the integration of digital technology into school curricula, and the evaluation of the knowledge developed by the students was not addressed. The objective was to create the conditions for the use of computers and investigate how the different proposals and approaches for use could be established in schools. Research was the EDUCOM Project's major merit. All of the pilot-centers were created with the objective of carrying out research, involving schools in the production of knowledge and development of competencies for the use of some of the most important resources in digital technology in education available at that moment, such as Logo, educational games, programmed instruction, and the use of software such as simulators, exercises and practice, word processors, etc. (Andrade, 1993; Moraes, 1997). However, it was necessary to think of the scalability of the dissemination of the knowledge generated. In this sense, the Immediate Action Program for Informatics in Education *(Programa de Ação Imediata em Informática na Educação*) was proposed.

Immediate Action Program for Informatics in K12 Education

In the beginning of 1986, the Advisory Committee for Informatics in Education (*Comitê Assessor de Informática na Educação* - CAIE/MEC) was created, chaired by MEC's secretary-general and constituted by renowned individuals in the country with technical-scientific competencies, from different segments of society. In April of this same year, the Committee recommended the approval of the Immediate Action Program for Informatics in K12 Education, coordinated by MEC's Informatics Department, anticipating actions such as: political diagnosis and guidelines for the development of digital technologies in education; development, production and application of educational digital technology; studies, research and experiments intended for the technological training in the area; training and development of human resources (creation of the FORMAR Project); and foment, disseminate, and publicize the results of the actions at a national and international scale (Andrade & Albuquerque Lima, 1993).

Establishment of the program and main results. One of the first activities of the Immediate Action Program was to evaluate the EDUCOM Project. This was carried out by a committee of high-level specialists. This committee concluded that the pilot-centers had developed the activities they set forth to do, despite the delay in the transferring of funds and the interruption of scholarships. The recommendation was for:

> The maintenance and revival of the technical and financial support for the pilot-centers, broader exchange between the researchers, and that research activities be the main focus of these centers so as to pursue reliable knowledge that would substantiate future political decisions, and ensure the ability to respond by anticipating problems and recognizing limits. (Moraes, 1997, n.p.)

Another important accomplishment of the Program was the creation and the development of the FORMAR Project, which offered specialization courses (360 hours or more) for training of teachers in departments of education, in universities, and in technical schools so that they could act as development professionals and train their colleagues in Centers for Educational Informatics *(Centros de Informática Educativa* - CIED) created in the state departments of education or in nucleus created in universities or technical schools. Three versions of the FORMAR Project were executed, and each one had a total of 50 participants. Two of these versions (FORMAR Project I and II) took place at UNICAMP, in 1987 and 1989 respectively (Valente, 1996), and the third version (FORMAR Project III) took place in 1991, at the Federal Technical School of Goiás (*Escola Técnica Federal de Goiás*).

During these courses, participants were in contact with subjects regarding digital technology and its pedagogic aspects separately. During the morning sessions, a group of 25 participants had "theoretical" classes regarding themes such as learning the concepts and foundation for the different uses of ICT in education, while the other group carried out practical activities for the use of computers, such as Logo programming, development of tutorials, and the exploration of educational software. During the afternoon session, the groups switched. The link between the theoretical and practical activities was up to the participants.

It is important to stress that, since the first Brazilian public initiatives represented by the EDUCOM and FORMAR Projects, there was strong participation of universities, responsible for conducting research. They were responsible for reinforcing actions and promoting the production of knowledge that would, in turn, reinforce the proposal of new initiatives and place Brazil amongst the countries of reference in this area of study. Therefore, today the country has research groups and research areas in various graduate programs, which contribute to the development of this field of study and serve as a point of reference to actions that aim to integrate technologies into educational practices.

After conducting FORMAR Project I, II and III, Centers for Educational Informatics *(Centros de Informática Educativa*) were established, being that 19 were CIED in partnership with the State Department of Education (*Secretarias Estaduais de Educação*), 15 Center for Informatics and Technical Education (*Centros de Informática na Educação Técnica* – CIET) in partnership with technical schools, and 8 Centers for Informatics in Higher Education (*Centros de Informática na Educação Superior* – CIES) in partnership with the Centers for Higher Learning and universities.

Three annual contests for Brazilian educational software also took place. During these contests, MEC released a call for proposals, stipulating the rules for the contest, and those interested submitted their products, which were then analyzed by a jury of specialists that would classify and award the best, from both a technical and pedagogic point of view. A Seminar also took place for the establishment of policies and guidelines for educational digital technology, as well as the Luso Latin American Seminar for Informatics in Education (*Jornada de Trabalho Luso Latino-Americana de Informática na Educação*) promoted by the Ministry of Education and financed by the Organization of American States (OEA; Ministério da Educação [MEC] & Secretaria da Educação Média e Tecnológica [SEMTEC], 1994; Moraes, 1997).

Therefore, the Immediate Action Program fulfilled its role of fomenting, disseminating, and publicizing actions for Informatics in Education, according to what was intended.

Analysis of the Immediate Action Program activities according to the Four Axes in Balance model and the Transversal Axis. In the axis vision, one can see the creation of a national network of professionals in education ready to help in the establishment of digital technology in education at all educational levels (K12 and universities), who joined together periodically to discuss the experiences that took place, and create new activities to undertake.

One can observe in the axis competencies the development of training sessions regarding the pedagogic use of computers that were aimed at professionals involved in the pilot program, such as researchers, administrators and teachers from the schools that participated in EDUCOM, and other professionals who participated in the FORMAR Project, as well as training sessions developed in the CIED, CIET and CIES (MEC & SEMTEC, 1994; Moraes, 1997).

In the axis content and digital resources, one can find the material developed by the research groups in the EDUCOM Project, such as Logo for computers MSX and Itautec I7000, programs for programmed instruction, educational games for computers with Apple and MSX systems, and the use of office software such as spreadsheets and word processors.

The axis infrastructure continues to be precarious in terms of the available equipment, basically depending on devices such as Apple, MSX and Itautec I7000. The FORMAR Project II provided participants with three personal computers, the PC IBM type, developed by Itautec, which had recently been released with different properties than the computers used up to that point. However, the use of these devices was restricted due to the lack of knowledge about these devices' functions, and to the low ratio of participants to device.

In terms of the transversal axis – curriculum, evaluation and research – the curriculum was not developed so as to integrate computational activities, since the activities carried out in the informatics lab were mostly dissociated from the content in the classroom. Even during the specialization courses offered through the FORMAR Project, issues related to curriculum and evaluation were not tackled. The production of content and applicability was expanded when the national contests took place. The developed software tried to address practically all areas of knowledge. Research was restricted to the pilot-centers and to the CIES created in the institutions of higher learning and universities.

National Program for Educational Informatics (PRONINFE)

Based on the actions conducted by the Immediate Action Program, postulates were developed for the creation of a national program for digital technology in education in the country, based on the understanding that Educational Informatics: is essentially a pedagogic "problem"; aims to improve teaching and learning processes, giving special attention to student and teacher performance; fosters the preparation of critical readers of information and reality; and provides for equal opportunity and access to cultural goods, capable of altering the quality of teaching and learning relationships, collaborating to perfect the dialectics of educational processes. (MEC & SEMTEC, 1994; Moraes, 1997).

Conception and premises. The National Program for Educational Informatics (PRONINFE) was created in 1989 in the General Secretariat of the Ministry of Education. In 1990 the PRONINFE was transferred to the Department of High School Education and Vocational Training (*Secretaria de Educação Média e Tecnológica*) in the Ministry of Education. It was established in 1992 with a budget line and with the following objectives: support the use of educational digital technology in different areas of study and levels of instruction, including in special education; stimulate the development of supporting infrastructure, together with the various educational systems in the country; promote human resources training in educational digital technology; foment research on the use of digital technology in teaching and learning, and create mechanism to disseminate the results; evaluate the development of plans, programs, and projects regarding the use of digital technologies in education (MEC & SEMTEC, 1994).

Based on article 205 of the Brazilian Constitution, which establishes that "education is a universal right and the duty of the Sate and the Family, a right that will be promoted and stimulated with society's collaboration." (Brasil, 1998, p. 34), PRONINFE considered as one of its premises

that digital technology is a cultural good to which all people should have free access. The socialization of digital technology entails in the involvement of various government sectors and institutions, one of which is the school (MEC & SEMTEC, 1994).

Although PRONINFE was instituted in 1992, with a specific budget line, no measure was conducted, for there was a halt in policies and activities in this area. It was only during a new governmental administration that a new national program was created, ProInfo, in 1997.

Analysis of PRONINFE according to the Four Axes in Balance model and the Transversal Axis. Although PRONINFE was never executed, it is important to recognize that its guidelines (MEC & SEMTEC, 1994) mention practically all the axes in the Four Axes in Balance, and the Transversal Axis, as will be shown below.

The axis vision was related to the socialization of digital technology as a cultural good that everyone should have free access to, foreseeing the establishment of digital technology in all levels of education, and contemplating research, training, the development of support material and computational infrastructure, and the evaluation of the implemented measures for digital technology in education.

Human resources competencies refers to training in the area of Education and Informatics, with the objective of preparing teachers to teach digital technology as a discipline – in the sense of guaranteeing the mastery of knowledge in this area – and to teach using digital technology – in other words, teaching based on the use of the computer. This Program had the intention of giving priority to proposals for the development of human resources that presented the following characteristics: be democratic and not determined by industrial or commercial interests; based on consciousness-raising and not indoctrination; involve large participation of universities and other Institutions of Higher Learning, as centers of excellence for education, research, and in-service training; prioritize researchers' training and improvement, particularly those involved with postgraduate programs; and develop knowledge of digital technology and pedagogy. In terms of digital technology, the content should accompany technological development, and, in terms of pedagogic studies, the content should include didactics, psychology, philosophy, and sociology of education; allow for contemplation, seeking the socialization of digital technology; promote links between the departments of Education, universities, and other institutions, such as the National Service for Industrial Learning (*Serviço Nacional de Aprendizado Industrial* – SENAI) and the National Service for the Learning of Commerce (*Serviço Nacional de Aprendizagem Comercial* - SENAC); and strengthen mechanisms for foreign exchange, fellowships, and internships in Brazil and abroad.

In the axis content and digital resources, one can see the objective of promoting the development of computational educational programs (software) through incentives for: the creation of interdisciplinary teams for the production and evaluation of educational programs based on the computer, qualified to address social, psycho-pedagogic, epistemological, and technical issues; the production of systems of tools; the acquisition of computational educational programs by public entities, that are properly evaluated by a research group with proven experience in the area of production or evaluation of these programs; the launching of quality educational programs in the market, that originate from research, in the sense of generating standards of quality; the creation of catalogues, databases, systems, and computational tools, and a glossary of technical terms pertinent to the area of educational digital technology, for the dissemination and consultation of information, at a national level.

The infrastructure foreseen by the Program was directed towards equipment that should be acquired so long as it met the following conditions: a definition of a basic configuration, with reduced cost, that could modularly expand and sustain its implementation; promote discussions, the application, and promotion of pedagogic tendencies, based on the use of equipment produced by

national industry, following standards that are unique to Brazilian reality, in order to define the equipment to be used in undertakings for Brazilian educational digital technology; and the possibility that the Ministry of Education act as a mediator and inducer of the process of computerizing Brazilian education, providing an incentive to the national industry to conform its equipment to the standards that would be defined.

In terms of the transversal axis, curriculum, evaluation, and research, one can see that: the priority was given to basic and applied research, developed by interdisciplinary teams; the Program promoted greater connections between development agencies; it channeled financial resources for the surveying of the "state of the art", researchers' training and improvement, for research and studies regarding the impact of digital technology on the educational sector, for the development and use of adequate computational tools, and for system evaluation.

However, the focus of the Program remained centered on the student and the teacher, and did not mention the school, despite its broad vision, which foresaw the establishment of digital technology in education in the three levels of education. Activities in the axes of infrastructure, content, and digital resources were foreseen, as well as the development of competencies. In addition, in the transversal axis, research actions were mentioned. These were to be conducted by professionals in universities on schools and the teacher's pedagogic practices. However, the Program did not address issues related to curriculum and evaluation; nor was the schoolteacher considered a researcher. Despite the advances observed in the axes, what becomes evident is the system's total ineffectiveness to put its program into action.

National Program for Informatics in Education (ProInfo)

ProInfo was created in 1997, during the beginning of a new government administration, with the following directives:

> (…) better the quality of the teaching-learning process; make possible the creation of a new cognitive ecology in school environments based on the adequate incorporation of new information technologies by the schools; provide education directed towards scientific and technological development; and educate for global citizenship in a technologically developed society. (Ministério da Educação [MEC] & Secretaria de Educação a Distância [SEED], 1997, p. 3)

However, the objectives delineated in the Activities Report 1996-2002 mentioned aspects that differ from the directives established at the time of the Program's launching, such as introducing telematics (telecommunication and digital technologies) into the K-12 public educational system as a tool for assisting the teaching-learning process, aiming to: better the quality of the teaching-learning process; provide education centered on scientific and technological development; prepare students to exercise citizenship; value the teacher. (MEC & SEED, 2002a).

Comparing the directives initially conceived with the objectives specified in the report, one can observe a gap between intentions and actions, particularly in relation to the breadth of the initial proposal as to an ecologic and interdependent vision, in contrast with the instrumental optic prevalent in what was executed.

ProInfo's activities can be grasped as happening in two stages: the first, from its creation in 1997 until 2006; and the second that began with the creation of Integrated ProInfo in 2007 until present day (ProInfo Integrado, 2018).

Establishment of ProInfo's first stage – 1997-2006. The Ministry of Education (MEC), through the Department of Distance Education (*Secretaria de Educação a Distância* - SEED) developed a series of programs and projects related to the use of technology in education. SEED, created in

1996, stimulated the development of training activities (for development professionals, administrators, and technical support) related to the use of technology in education, the purchasing of digital technology equipment related to ProInfo, and coordinated actions developed by Centers for the Experimentation of Educational Technology (*Centro de Experimentação em Tecnologia Educacional* – CETE[5]).

ProInfo, created in 1997 and coordinated by SEED, was a program that encompassed all of the national territory, giving support to State Education Departments and a few Municipalities for the establishment of digital technologies in the school systems, seeking to introduce ICT in public schools as a tool for supporting teaching and learning processes. In order to do so, ProInfo developed two measures that took place simultaneously: the establishment of digital technology labs in schools, and the training of teachers in all subject areas so that they could use this equipment as a strictly pedagogic resource, integrated with activities in the classroom. Considering the dimensions and scope of the public school system that would benefit from this Program – approximately 6000 schools until 2002 – the strategy was to organize its implementation in two phases: the first phase consisted in setting up Nucleus for Educational Technology *(Núcleos de Tecnologia Educacional* - NTE) and training teacher development professionals, selected amongst those belonging to the public school system and trained through specialization courses (360 hours) to act in these nuclei; and the second phase consisted in the establishment of digital technology labs in schools, and in giving continuity to teacher training.

During the first phase of the Program, NTE were idealized as decentralized structures that would support the process of computerizing schools, helping not only in the planning and establishment of ICT in the public school system, but in the schools' technical and pedagogic support, in raising awareness and training teachers and school administration. These teacher development professionals also monitored and evaluated activities regarding the use of ICT in the NTE and in the schools. In addition to the training courses, teacher development professionals had the chance to participate in ProInfo's National Meetings, which took place 8 times during the period of 1997 to 2002 (MEC & SEED, 2002a).

In each Brazilian State, within the State Department of Education, a ProInfo State Office was created, with the objective of coordinating actions for digital technology in the school system and mentoring the NTE as to the process of establishing digital technologies in schools, in addition to being the link between MEC and the NTE. A computing platform was also created, eProInfo, intended for the development of virtual learning environments in order to offer distance education courses.

Maintaining this organization and structure, Nucleus for Educational Technology within Municipalities *(Núcleos de Tecnologia Educacional dos Municípios* - NTM) were also created, each one with municipal coordinators, which represent the municipality in policies and actions for ICT in education. Table 1 compares what was planned to what was executed in terms of the students who benefited, the schools serviced, NTE established, development professionals, technicians and coordinators trained, and computers installed until the year of 2002.

[5] CETE had the objective of "researching and developing educational solutions of interest to ProInfo and Distance Education, conducting courses for teachers and technicians, executing demonstrations of technical-pedagogic solutions, and providing technical-pedagogic support in the area of the educational use of new technologies, NTE and schools" (MEC & SEED, 2002a, p. 7)

Table 1
What was planned and executed by ProInfo until the year of 2002

WHAT WAS PLANNED AND WHAT WAS EXECUTED		
	Established goals	*What was achieved*
Students who benefited from the program	7,500,000	6,000,000
Schools serviced	6,000	4,629
NTE established	200	262
Development professionals trained	1,000	2,169
Teachers trained	25,000	137,911
Technicians trained	6,000	10,087
Administrators trained		4,036
Computers installed	105,000	53,895

Source: (MEC & SEED, 2002a, p. 5)

According to the data in Table 1, until December 2002 some of the goals had been achieved, such as the number of NTE established, and teachers, coordinators and technicians trained. However, goals regarding services for students and schools, and the installation of computers were not achieved.

ProInto created digital technology labs in the schools and offered training courses to development professionals and teachers, who aimed to create a link between technological and pedagogic facets. However, in practice, since activities took place in the labs, they were disconnected from events in the classroom, making it difficult to integrate what was taking place in the classroom and in the lab. In addition, the various professionals who worked in different programs of the Department of Distance Education (SEED/MEC), such as in School TV (*TV Escola*), the Program for Training Currently Acting Teacher (*Programa de Formação de Professores em Exercício* – Proformação), and School Radio (*Rádio Escola*), in municipal and state education departments (a few had their own initiative), and the in NTE, defined the project's activities for which they were responsible for carrying out in the schools in an isolated manner. In many cases these activities were developed without interactions, negotiations regarding agenda, and linkage between the proposed activities, which made it even harder to integrate technology into the pedagogic practices in the classroom and to develop curricula.

During this period, SEED also developed the Virtual International Network for Education (Rede Internacional Virtual de Educação - RIVED; MEC & SEED, 1999), a program aimed at the production of digital pedagogic content, as a result of an agreement signed in 1997 between Brazil, the United States, Peru and Venezuela, for the development of technology for pedagogic use structured as learning objectives.

The integration of the various programs and activities related to distance education took place as of 2002, after the VIII National Summit by School TV (*VIII Encontro Nacional da TV Escola*) occurred in Curitiba/PR, with the theme "Unity and Integration in Distance Education" (*"Unidade e Integração na Educação a Distância"*; MEC & SEED, 2002b). This resulted in the merging of actions by ProInfo, School TV and Proformação. The latter certified teachers in the public school system without a teaching diploma, in the Northern, Northeastern and Midwestern regions of Brazil.

In November 2004, the Public Domain Portal (*Portal Domínio Público*) was launched, aggregating part of the material developed by RIVED and the activities developed through ProInfo (MEC & SEED, 2016a). This Portal was a virtual library with open access online, which allowed for the assembling, inclusion, and selection of literary, artistic, and scientific work in various formats and medias (text, sound, images, and videos), with an automatic search mechanism.

In 2007, ProInfo was transformed into Integrated ProInfo, thus initiating a new phase. Until 2006, ProInfo acquired 147,355 microcomputers, and 5,564 municipalities, 507,432 teachers, and 13,366,829 students benefited from the program ([MEC] & Sistema de Gestão Tecnológica [SIGETEC], 2006).

Establishment of ProInfo's second phase – 2007-2016. Considering that ICT were still not connected to the activities that took place in schools, particularly in the classroom, in December 2007 ProInfo was transformed into Integrated ProInfo, with the objective for bringing together different projects, actions, and resources offered to schools, and the inter-relation between teaching and learning. Integrated ProInfo's implementation took place through various measures to better increment the establishment of ICT in public schools, which included infrastructure, training and digital content, interactions, communication, and virtual communities (Bielschowsky, 2009).

During the period of 2007 to 2016, activities and Programs took place as part of Integrated ProInfo. One is the in-service training named Integrated ProInfo, created by SEED/MEC and offered by departments of education and Nucleus for Educational Technology in states and municipalities (NTE and NTM), aimed at training educators in three training modules, one of which focused on the development of technological fluency, and the other two focused on the integration of ICT into teaching and learning processes. This course continued to be offered by NTE and NTM.

The Program for Media in Education was created in 2006 by SEED and aimed to train, through distance education courses, teachers, administrators, and pedagogic coordinators in schools in the public school system for the pedagogic use of different medias such as: TV, videos, digital technology, and radio. It was developed through a partnership with Public Institutions of Higher Learning (*Instituições Públicas de Ensino Superior* - IPES) and structured as modules, in which there are different possibilities for certification: In-Service Development (120 hours), Professional Development (180 hours) and Specialization (360 hours; MEC & SEED, 2006). The Administration for Professional Improvement in Higher Education (*Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* – CAPES) took over this program in 2009.

Rural ProInfo was created in 2007 to establish digital technology labs in elementary and middle schools in rural areas that had more than 50 students, infrastructure for electricity, and which did not already have a digital technology lab. Urban ProInfo aimed to create labs in urban areas, specifically in middle schools with more than 100 students and electricity.

Project One Computer per Child (*Projeto Um Computador por Aluno* – UCA) began in 2007 and put laptops in the hands of teachers and students, and, therefore, made the presence of technology in the classroom possible. About 150,000 laptops were distributed to 350 state and municipal public schools, urban and rural, being that each school could not surpass 500 students and teachers.

The Program Broadband in Schools (*Programa Banda Larga nas Escolas*) was launched in 2008 by the Federal Government, with SEED's operational management, with the objective of connecting all public schools to the Internet, a world network of computers, through technologies that would make quality, speed, and services available to better public school teaching in the country.

Teacher's Portal (*Portal do Professor*) was "launched in 2008, in partnership with the Ministry of Science and Technology, had the objective of contributing to Brazilian teacher training processes and to enrich their pedagogic practice" (MEC & SEED, 2016b, n.p.). This is a virtual space accessed via the Internet that makes digital educational resources available, such as videos, photos, maps, audios and texts, collaborative spaces, YouTube portal, interactions and exchange of experiences amongst teachers, newspapers, courses and materials for studying, database with suggestions of classes regarding content in school curricula for each area of study, courses and news, in addition to

links to other of MEC's portals and to a collaborative environment for learning, e-ProInfo, maintained by MEC.

The International Database of Educational Objects *(Banco Internacional de Objetos Educacionais* - BIOE) was created by MEC in 2008, in partnership with the Ministry of Science and Technology, the Latin-American Network of Educational Portals (*Rede Latinoamericana de Portais Educacionais* - RELPE), and the Organization of Ibero-American States (*Organização dos Estados Iberoamericanos* - OEI), is made up of an open access repository of educational objects, in various formats and languages, with content from different areas of knowledge and levels of education, such as free educational resources (audio, video, animation/simulation, images, hypertexts, and educational software; MEC & SEED, 2016c).

The development of technological devices also took place through Integrated ProInfo. These included: interactive projector, equipment consisting in a processor, keyboard, mouse, USB ports, access to the Internet, DVD player, and an internal data show; the distribution of technological devices such as portable digital blackboard for projecting digital content, which can be stored in the school server or accessed via the Internet, file sharing, recordings of classes, and tablets distributed to teachers in high schools in the public school system. This project began in 2012 (Ministério da Educação [MEC] & Secretaria da Educação Básica [SEB], 2013) with the goal of making equipment (computers, tablets, and digital blackboards) available, and train educator for the use of ICT in teaching and learning, with an emphasis on training. The intention was to purchase 600,00 tables that would be distributed to teachers in a portion of the high schools (Ministério da Educação [MEC] & Fundo Nacional de Desenvolvimento da Educação [FNDE], 2016), and produce a specialization course, though information as to how many tables were in fact distributed is not available.

The Specialization Course in Education in the Digital Culture (*Curso de Especialização em Educação na Cultura Digital*), executed by MEC's Department of Basic Education *(Secretaria da Educação Básica* - SEB), and conceived and produced by the Federal University of Santa Catarina (*Universidade Federal de Santa Catarina* - UFSC) offered a new model for teacher's continuing education, with a focus on shared experiences amongst educators of activities using ICT in pedagogic practices with students, with the objective of propitiating the development of a digital culture in schools. The course was produced with the collaboration of renowned researchers in distinct areas of knowledge who worked together to train educators and teachers in public schools for the use of ICT. The team coordinating the development of this course was sustained by two committees – the Management Committee (*Comitê Gestor*) and the Scientific Pedagogic Committee (*Comitê Científico Pedagógico*) – which worked together to define the idea behind the training, the structure of the course in work centers (basic, applied and specific areas of knowledge), the dynamic of inter-relations between the work centers, in addition to monitoring and guiding the production of content, so as to give support to the coordinating team. This course was catered for teams of teachers and administrative from Brazilian public schools, development professionals from NTE and NTM, and can be offered by distinct Brazilian institutions of higher learning, through distance education courses (Cerny et al, 2017). All of the content of the work centers is made available through catalogues for public use on MEC's site (2016).

Towards the end of 2017, MEC launched a new program for ICT in Education named Program for Innovation Connected Education (*Programa de Inovação Educação Conectada* - PIEC; Ministério da Educação [MEC] & Secretaria de Regulação e Supervisão da Educação Superior [SERES], 2017), which encompasses ProInfo and is unique for implementing integrated actions in distinct areas, so as to cater to different realities and demands for the use of ICT in schools. This

includes infrastructure, digital educational resources, and assistance for administrators to formulate investment in technology plans, an initial training project, and continuing education for teachers.

The main results obtained, concerning the devices installed and the people serviced up to 2012, were presented in the Management Report for the Year 2012 (*Relatório de Gestão do Exercício 2012*) by MEC's Department of Basic Education (*Secretaria de Educação Básica* – SEB; Brasil, 2013). Table 2 makes the progress attained evident in terms of equipment installed, as compared to Table 1, which refers to the activities and results from the period of 1997 to 2002.

Table 2
Equipment installed in the year 2012

DEVICES	GOALS ACHIEVED
Tablets	480,000
Computers with digital blackboards	56,562

Source: 2012 Annual Report (*Relatório de Gestão do Exercício 2012* – MEC & SEB, 2013)

According to Table 2, until 2012 more than 500,000 devices had been installed, amongst tablets and digital blackboards, surpassing the number of computers installed between 1997 and 2002 (Table 1).

The Management Report for the Year 2012 (MEC & SEB, 2013) states that all of ProInfo's activities centered on technology in education training, including Media in Education and Project UCA, reached 15000 people in the entire country, most of which were teachers in the public school system. This demonstrates that the focus of the year 2012 was mostly on installing equipment (Table 2), particularly distributing tablets, rather than serving people. Such results show a moment of disjuncture in policies, particularly when looking at training teachers and administrators.

Analysis of ProInfo's activities according to the Four Axes in Balance model and the Transversal Axis, curriculum, evaluation and research. Concerning vision, there are records that show that ProInfo foresaw an ecosystemic education focused on scientific and technological development, and the development of global citizenship, seeking to integrate different components that are part of instituting public policy for technology in education.

However, although ProInto maintained itself as a large umbrella that joined together different initiatives by MEC in the field of technology in education, one cannot observe cohesion amongst these initiatives, nor inter-relation between the actions proposed, such as, for example, between the specialization courses in Media in Education offered by public universities, and the in service training Integrated ProInfo, offered by the NTE/NTM, despite the fact that both were designed and elaborated under the Ministry of Education's supervision. This indicates that ProInfo's main characteristic is focused on distributing devices to schools and offering content, carrying out courses that were not continuous or related to each other, revealing that the macro vision was fragmented and made up of isolated initiatives.

The importance of this cohesion became evident in Project UCA's proposal, which encompassed various aspects that are part of the process of implementation and integration of ICT in education, more specifically, in schools and in the classroom, with the possibility of including spaces outside of schools. However, this cohesion did not take place during UCA's implementation, as seen in Almeida and Valente (2018).

Therefore, the vision of what was implemented by ProInfo is very functional. Even the subprograms or projects that were associated to ProInfo, such as Project UCA and the Specialization Course in Digital Culture, suffered interference from a macro level, affecting the

remaining levels in the system's structure involved in giving continuity to the activities, responsible for a change in focus, and for the financial support of the activities already being executed.

In the axis competencies, one can observe that ProInfo created various actions that allowed for the training of researchers in institutions of higher learning and research centers, of countless teacher development professionals in practically all the regions of the country, and of teachers in schools. This ability to train teachers developed by the development professionals can be understood as ProInfo's major legacy. Today it is possible to count on the collaboration of competent professionals for the implementation of research activities or even teacher training and support of practices for technology in education, in any part of the country, as was the case with Project UCA in which these professionals were actively involved. Another project that allowed for great advancements in the conceptualization of what the integration of the school and digital culture means was the Specialization Course in Education in the Digital Culture, as has been previously mentioned. However, though the idea behind the course was innovative, its idea is only made possible in practice as a consequence of training, but this training has not been offered.

The axis content and digital resources shows that ProInfo had a fundamental role in the development of content and digital resources, such as the creation of the Teacher Portals, of the Public Domain Portal, and of the International Databank of Educational Objects (*Banco Internacional de Objetos Educacionais* - BIOE) portal, in addition to making content from the developed courses available for use by the departments of education and universities. By 2003, 120 objects for Biology, Chemistry, Physics, and Mathematics had been created, all of which could be accessed by the public. In 2004, universities became responsible for the production of objects for learning, under SEED's supervision, at which point RIVED was given its name, Interactive Network for Virtual Education (*Rede Interativa Virtual de Educação*), and production increased.

However, without Internet connection it is impossible to access the material available in any database of educational objects. Thus, although there is an abundance of digital material developed with the support of ProInfo, without access it is almost as if this material didn't exist. Funding existed from MEC and from other sources destined to the production of digital educational material by public universities, in addition to production incentives for schoolteachers themselves, with MEC's help to curate and make the material available, in the Teacher's Portal and in BIOE, but all this effort does not result in effective use without creating the conditions for this to take place.

Concerning Infrastructure, one can identify that ProInfo concentrated its efforts in the creation of digital technology labs and in the installation of Internet networks in public schools, in addition to placing portable computers in approximately 300 public schools. Finally, it was possible to create labs in practically every urban school and in the majority of rural schools.

According to the 2013 report from the Department of Justice (*Controladoria Geral União* – CGU; Brasil, 2013), by June 2010, ProInfo had delivered 56,510 labs, of which 34,223 were in urban schools and 22,287 in rural schools, servicing 92% of the 5,561 Brazilian municipalities that joined the Program. About 30% of these labs had not been installed, and 66% of them were not adequately installed. Lack of training for teachers and technicians was identified in 27.1% of the locations, making the pedagogic use of the technologies difficult. Based on these results, CGU recommended that improvements be made in the process of purchasing technologies for schools, as well as in the training and orientation of teachers and technicians, and in monitoring the use of these labs.

Regarding the transversal axis, curriculum was not affected by ProInfo's activities. The link between curricular activities and activities carried out in the labs is minimal due to the conditions delimited by issues of space and time for use of the labs. Research was occasional, carried out by researchers from the universities, but did not affect the development of actions by ProInfo. On the contrary, the results from these researches were generally ignored and did not help give new

direction to the development of the project. The most successful case was the analysis of the Specialization Course for the Development of Pedagogic Projects with the Use of New Technologies (*Curso de Especialização em Desenvolvimento de Projetos Pedagógicos com Uso das Novas Tecnologias*). The objective of this course was to provide the theoretical-methodological conditions for teacher development professionals in the public school system to use technology integrated with pedagogic practices, with an emphasis on the development of projects (Prado, 2003; Valente & Almeida, 2007). The course trained 35 teacher development professionals, and its idea and curriculum influenced the development of Integrated ProInfo.

On the other hand, Project UCA allowed for an analysis and understanding of changes regarding the curricula, since laptops became available in the classroom and other school environments, allowing for mobility of information, learning, and training, interfering in curricular activities. Furthermore, research was developed with the schools and universities, supported by a specific funding and call for projects that involved CNPq, CAPES and MEC, as described in Sampaio and Elia (2012).

Lessons Learned

Public policies must be reassessed considering their elaboration, establishment, implementation, and evaluation. Thus, an analysis of the main public policies, programs, and projects developed in Brazil over approximately 30 years, inspired by the axes in the *Four in Balance* model resignified to Brazilian reality, indicates that it is important to regard the past, highlight lessons learned, so as to project the future based on what was possible to achieve up to the present moment, and consider the emergent needs of all the people affected by these public policies.

Knowledge developed throughout Brazilian history regarding ICT in education affected by cultural, educational, and social diversity, lead to a resignifying of the original *Four in Balance* model according to the nation's public policies, considering the importance of the search for a balance between the four axes, and broadening of the model with the proposal of a new transversal axis made up of curriculum, evaluation, and research. This redevelopment guided the analysis of Brazilian public policy, and brought a new understanding of the lessons learned. We highlight the analysis of ProInfo that, from is initial conception, allowed for the interlinking between training, research, curriculum, and evaluation. However, infrastructure and connectivity were not associated to these other dimensions.

The analysis we began demonstrates that Brazilian policies for technology in education, represented by ProInfo, which up to this moment represents the longest lasting policy with the largest dissemination in the Brazilian educational system, was not able to establish a balance between the four axes, though we identify significant improvements in two of the axes – **content and digital resources** and **infrastructure**. The axis **vision** is unstable, succumbing to constant changes in the administrators that lead these public policies, and the axis **infrastructure** demonstrated to be limited in terms of its influence in schools. The lack of balance between the axes compromises the success of the established goals, and the effectiveness of actions in schools, discrediting the policies in the eyes of educators and the school community.

Furthermore, universities played an important role from the onset, participating in initiatives that stemmed from the first national seminars, in the execution of Project EDUCOM, and in the final activities relative to Integrated ProInfo. Such participation allowed for the implementation of research projects that were subsidiary to public policies, to the development of knowledge about technologies in education, and the training of professionals. In this sense, the authors of this paper, professors at universities, developed and advised research projects, participated in consultant

committees for the Ministry of Education and secretaries of education in states and municipalities, and participated in working groups with professionals from NTE and NTM, as well as in schools, in addition to having conducted research with the schools and their subjects (administrators, professors and students).

Research projects with themes related to technology in education in schools that are both public and private, where one observes a condition that is closer to a balance between the four axes, identify that there are significant benefits when teachers have a conception of the pedagogic use of technology beyond its instrumental use, emphasizing curriculum, evaluation, and student and teacher's research, as seen in dissertations by Cerqueira (2014), Vale (2018), Watanabe (2019), and Piorino (2012), as well as in publications by Valente, Baranauskas e Martins (2014), amongst others. Though these cases are limited to the scope of specific schools, they are public documentations and can serve as reference to other experiences. Such dissemination has the potential to possibly influence the definition of new policies.

It is important to stress the role played by the NTE and NTM since the establishment of ProInfo, which were created as decentralized units that would support schools and educators' continued training, and for which universities were responsible for the initial training and the preparation of new development professionals to act in these NTE. Similarly, labs existent in schools can be resignified with the emergence of Mobile Technology with Wireless Connection (*Tecnologias Móveis com Conexão Sem Fio* - TMSF) to the Internet, disseminated in the population and commonly found in students' and teachers' hands, such as tablets, smartphones, etc. For this reason, labs become spaces for production, creation, and development of new materials, while the classroom becomes a space for connectivity, for the articulation of media languages, and for multiple uses of resources and TMSF that can be transported between classrooms so as to access and create information, communication, interaction, participation, and the development of knowledge.

The qualitative results regarding public policy for the use of ICT in Education obtained through academic research has been fundamental to guide new measures. For example, results from such studies lead to an understanding of the importance of training focused on the development of a digital culture in schools (Valente, Almeida & Kuin, 2017) and of the curricula for a digital culture (Almeida, Valente, Kuin & Silva, 2017), aspects that guide the elaboration of the Specialization Course in Education in the Digital Culture (*Curso de Especialização em Educação na Cultura Digital*). In this course, one can observe the presence of a few fundamental aspects for the sustaining a public policy, such as a vision of its initial idea, leadership by the coordinating team, and competencies of those developing the course, as well as the educational approach, which aimed to develop competencies in the enrolled teachers regarding the role of the teacher in the digital culture, of updated and accessible digital content and resources through the internet with other supporting material, of infrastructure and of related research. However, vision was hindered in relation to the macro institution of power played out by MEC, due to constant changes in administration over the last few years, which lead to a halt in fellowships for training and, therefore, the availability of courses became restricted to three pilot courses carried out at the Federal University of Santa Catarina (*Universidade Federal de Santa Catarina* - UFSC, the Federal University of Roraima (*Universidade Federal de Roraima* - UFRR) and the Federal University of Outro Preto (*Universidade Federal de Ouro Preto* - UFOP). Training offered by the remaining institutions was suspended due to the lack of fellowships.

Other lessons learned are based on the concern with technological infrastructure and connection to broadband Internet in the schools, in homes, and in varying social spaces, due to the characteristic of current technological devices such as TMSF. We part from the premise that it is the right of every citizen to have access to, and to use, TMSF, since these are already in the hands of a

considerable part of the population and need to be made available to all, so that everyone might have access to cultural goods and services offered to citizens through the Internet. Therefore, there is a hope to advance in diminishing the digital divide, which worsens social inequalities, and for Brazil to reach the standard of a digital society that is inclusive and equitable, and that uses ICT ethically and with social, cultural and educational meaning. However, there is a need to not only make these devices available, but also to stimulate infrastructure and connectivity, monitor its implementation, and to rethink curriculum, learning, evaluation, research, and training for citizens of the digital culture.

In the case of Project UCA, laptops were sent to some schools that did not have electrical and digital infrastructure, or connection to the Internet. As a return for the project, the public schools system and schools themselves were responsible for assuming infrastructural adaptations, being that these changes were not part of the department of education's policies or of the school's project; schools with no resources to implement the necessary changes were not consulted as to whether they had an interest in participating in the Project. The lesson remains as to the need of a national coordinator with a vision of the whole, and that plays the role of a mediator between the distinct structures that make up the public educational system, including the schools, which should participate in the definition of policies for ICT in education. Through the Internet, the distinct layers of the system's structures should exchange and participate in the process of elaborating new proposals, of decision making, monitoring and evaluating actions, thus no longer simply executing what is defined by others, but taking on the role of building a network for teaching, training, and learning, with an ecological stance as to the importance of accepting diversity, collaboration, and change (Pinazza, 2014).

It is important to highlight that a majority of initiatives to promote change in Brazilian education did not stem from within in system or from the teachers' demands, but was imposed from the outside and from the top. This has taken place in practically all educational reforms in Brazil, which are established by a central power and meant for the remaining institutions in the federal structure. Most recent examples include the National Curricular Parameters (*Parâmetros Curriculares Nacionais* – PCN) and the inclusion of ICT in schools, such as in the case of ProInfo. Initiatives conceived by federal government offices and implemented through partnerships with state and municipal institutions do not produce the envisioned changes. Here we can use the metaphor of the egg – when it is broken from the outside it can produce omelets, cakes etc. When broken from the inside it allows for the egg's sustainability and in some cases produce results that can fly!

The centralizing culture of the federal government is so powerful that the teachers at the frontline, facing 30 or 40 students, still accept changes that were made for them and not by them (Weston & Bain, 2010). This is a problem particularly in Brazil where, in addition to the centralization and regulation by public authority, the excess of the teachers' workload is worsened by other problems related to inadequate training and lack of the necessary working conditions to carry out their job with dignity.

Finally, other lessons learned consider the important contribution of the use of models that allow for one to describe and analyze essential aspects that must be considered in the evaluation and creation of new policies for technology in education, such as the aspects highlighted in this article.

Current challenges are complex and a unique solution does not exist! Schools and educators are not able to make this change in isolation. It is important to involve all the structures in the educational system, invert processes rather than propose centralized policies and homogeneous measures. It is possible, and maybe less taxing, to create the conditions for the structures within the public school system and within schools themselves to create their own innovative solutions given their contexts. It is a matter of facilitating the creation of disruptive innovations (Christensen, 1997),

which can emerge from specific contexts, privileging a diversity of starting points and development processes, characterized by its decentralized quality, that allows for the development of new practices from within the schools, considering aspects of cultural and social diversity inherent to the school's reality.

Figueiredo (2011) stresses the important role of media and ICT in the development of disruptive innovation, as well as the need for policies that support the "creation of lasting partnerships between school communities and institutions of research, focused on projects for investigation-action and designed based research" (Figueiredo, 2011, p. 24). These activities involve researchers from universities and teachers in schools, in a process of reflecting and action-research carried out together with teachers in schools, with a focus on changes in practices and curriculum (Sampaio & Elia, 2012).

Through the development of learning networks and sharing of experiences, other schools can appropriate the proposal for innovation and resignifiy them to their own reality, in the process of endemic contamination (Hargreaves, 2003). According to this author, transformation is possible when governments provide infrastructure, support, and resources allocated according to local criteria, in addition to changing the emphasis on the simple use of ICT to the development of creative communities, providing incentives for disciplined self-governance, innovation, and sharing. The central aspects of this process for creating contextualized innovation are the networks and virtual communities of engaged educators, who laterally share their experiences. Transformation is not achieved by itself simply based on demands from the system, it is important to minimize directives and the regulating legislation, diminish the degree of intervention, and create conditions that foster diversity and allow it to flourish.

Creative schools that produce knowledge, work with problems, projects and other dynamics focused on active learning, demonstrate the need for teachers that are prepared and interested in incorporating ICT into their pedagogic practice. Integrating pedagogic knowledge, technological knowledge, and content knowledge, requires consistent and sustainable policies, as specified in the conception and procedure of the four axes and a transversal axis model, which demonstrates fundamental elements for the elaboration of new policies for ICT in education.

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