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- Open conferences;
- Working conferences.

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Arthur Tatnall Anthony Jones (Eds.)

Education and Technology for a Better World

9th IFIP TC 3 World Conference
on Computers in Education, WCCE 2009
Bento Gonçalves, Brazil, July 27-31, 2009
Proceedings

Springer

Volume Editors

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Preface

Education and Technology for a Better World was the main theme for WCCE 2009. The conference highlights and explores different perspectives of this theme, covering all levels of formal education as well as informal learning and societal aspects of education. The conference was open to everyone involved in education and training. Additionally players from technological, societal, business and political fields outside education were invited to make relevant contributions within the theme: Education and Technology for a Better World.

For several years the WCCE (World Conference on Computers in Education) has brought benefits to the fields of computer science and computers and education as well as to their communities. The contributions at WCCE include research projects and good practice presented in different formats from full papers to posters, demonstrations, panels, workshops and symposiums. The focus is not only on presentations of accepted contributions but also on discussions and input from all participants.

The main goal of these conferences is to provide a forum for the discussion of ideas in all areas of computer science and human learning. They create a unique environment in which researchers and practitioners in the fields of computer science and human learning can interact, exchanging theories, experiments, techniques, applications and evaluations of initiatives supporting new developments that are potentially relevant for the development of these fields. They intend to serve as reference guidelines for the research community.

Proposals were invited on a wide range of topics relevant to the theme and included, but were not limited to these streams (based on the Stellenbosch declaration, WCCE 2005):

- Digital solidarity
- Learners and lifelong learning
- Teachers – teaching and role of teachers
- Decision making strategies/policy
- Networking and collaboration
- Innovation and creativity in schools
- IT security in Academia
- Informatics, programming and problem solving

Perspectives:

- societal perspective
- learning and teaching
- technology and infrastructure
- research

It is usual for the conference to reflect new trends, presenting the more relevant research in the area. Among the hot topics that have often been discussed there, we

can cite those in the areas of innovation and creativity in schools, informatics, digital solidarity, learners and life long learning, networking and collaboration and teaching and the role of teachers.

Along with traditional paper sessions the conference had several symposia and expert panels for professional in-depth discussions and reflections. A special stream was dedicated to Lifelong Learning under the IFIP AGORA umbrella. The Workshops also complement the main conference by providing a more focused target audience for discussion of current topics of interest. These activities are not reported in this book or the CD proceedings but were aimed at initiating or continuing activities and events throughout the world after the conference.

All this has been the tradition since the First World Conference on Computers in Education (WCCE) that was held in Amsterdam, The Netherlands in 1970, and these conferences have since then been organized every fourth to sixth year in: Marseille (France), Lausanne (Switzerland), Norfolk (USA), Sydney (Australia), Birmingham (UK), Copenhagen (Denmark) and Cape Town/Stellenbosch (South Africa) before finally arriving in Bento Gonçalves, Brazil this year – the first time in South America.

The main goal of the **WCCE 2009** proceedings is to offer a venue for the presentation of a sample of the best papers submitted to the WCCE 2009 Research Track. In particular, this special issue is of relevance to anybody interested in current research in computers and education and the development and use of relevant applications and tools. This keeps with the spirit of the event, which aims at stimulating contact between participants in order to exchange experiences on applications, methodologies and management of educational hardware and software.

We would like to thank all the scientists who contributed to this WCCE 2009 edition. We received 289 contributions to the conference, whereof 146 were accepted as full papers, and finally 48 of these were selected as the best papers to be published in this book. All conference papers were peer reviewed by at least three reviewers, and those published in this book were subjected to additional peer review before acceptance.

We also thank the members of the International Program Committee who did a very good job and worked hard given the total number of contributions we received. Moreover, we want to express our gratitude to the editors Arthur Tatnall and Anthony Jones for making this book a reality.

Finally, we are also grateful to the WCCE 2009 organizing team, our sponsors and in particular to the participants. WCCE 2009 was an IFIP event hosted by the Computer Society of Brazil and organized by UFRGS (Universidade Federal do Rio Grande do Sul) UFSC Universidade Federal de Santa Catarina, and IDESTI (Instituto de Capacitação, Pesquisa e Desenvolvimento Institucional em Gestão Social de Tecnologia de Informação).

May 2009

Sindre Røsvik
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Part I

Invited Papers from Brazil

Scientific and Technological Education in Brazil: Advancements and Challenges for the 21st Century

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Abstract. There is a complexity of challenges related to scientific and technological education in Brazil, including literacy in basic concepts and principles by students; better pre- and in-service teacher training; sufficient supply of computers, internet and other technological resources to all Brazilian public schools; provision of teacher training on how to effectively use such tools; and promotion of public awareness of science and technology and their vital role socioeconomic development and sovereignty. Recognizing the importance of fostering usage of technologies in education and the urgency of promoting and encouraging synergic efforts in the development, implementation, monitoring and evaluation of policies/programs/projects for science and technology in pre-college education, it was created in 2008, the Coordination of Educational Technologies, in the structure of the Brazilian Ministry of Education. This paper aims to: a) provide a general panorama of Brazilian education; b) discuss some current Brazilian efforts targeted to the advancement of scientific and technological education in pre-college education. As an illustration, we present the so-called "Guide of Educational Technologies," a publication that allows educational managers to select resources that contribute to the enhancement of education in their school systems. This publication offers a wide range of educational technologies, such as in-service courses for teachers, web resources, software and programs targeted to several educational areas and demands.

Keywords: Science education, educational technologies, quality in education.

1 Introduction

Education is a fundamental pillar for the construction of a project of society committed to the promotion of sustainable development and social welfare. Any sovereign nation based on principles of democracy, social equality, and ethics is sustained by an inclusive education. For this reason, the Brazilian Ministry of Education has been working towards amplifying access and enhancing quality of education offered in both public and private educational systems. For the Brazilian government, education represents an investment and priority for present and future. It is also a legitimate right of every Brazilian citizen.

A. Tatnall and A. Jones (Eds.): WCCE 2009, IFIP AICT 302, pp. 3–13, 2009.

In order to better contextualize Brazilian education, we present some aspects of our State. The Brazilian State is a Federative Republic composed of 5.564[1] municipalities, distributed in 26 states and a Federal District and constitutes a legal democratic state, founded on principles of sovereignty, citizenship, dignity of the human person, social values of labor and of free enterprise and political pluralism, according to its Federal Constitution of 1988. A considerable fraction of public policies, such as the educational one is executed in collaborative regime with states, municipalities and the Union. This regime is foreseen in the federative pact, as a constitutional principle.

The Brazilian national territory extends over 8.514.876.599 km^2,[2] and is divided in five geographical regions that present, despite a linguistic unity, extremely heterogeneous cultural and socioeconomic patterns. As a consequence of differentiated levels of industrialization and socioeconomic development, states and municipalities in different regions present unequal levels of investment and management potential, mainly in societal areas. Such inequalities also lead to disparities in the educational sector, in regard to both economic-financial and qualitative aspects.

The Brazilian educational system is divided in two levels: basic and higher education. The basic level comprises early childhood education (kindergarten and preschool), devoted to children from 0 to 5[3] years old; elementary and middle education, which sum up nine years of compulsory education, from 6 to 14 years old; secondary education, ranging from 15 to 17 years old, which has been integrated to vocational education, preparing youth for the labor market and to continuation of studies. It also comprises modalities such as youth and adult education, devoted to those did not have access or continuation of studies at regular age, and special education, responsible for assisting impaired students, preferably in regular educational systems.[4]

As mentioned previously, public educational policies in Brazil are carried out in an intergovernmental collaborative regime. States, the Federal District and Municipalities are autonomous in the management of their respective education systems. The Ministry of Education, by constitutional principle, exerts normative, re-distributive and supplementary functions, coordinating and proposing educational actions at national level.

The Brazilian educational system is composed of public and private institutions, which follow curricular guidelines elaborated by the National Council of Education (CNE), normative organ associated to the Ministry of Education. In the division of responsibilities regarding the offer of education in the public sector, the Union is responsible for offering higher education. Primary and secondary education should be offered by both state and municipalities. A considerable parcel of secondary education is under the responsibility of states and a certain contingent is managed by federal sphere. Municipalities are responsible for offering early childhood and elementary education with priority.

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[1] Brazilian Institute of Geography and Statistics – IBGE, Brazil in Numbers, v. 14, 2006.

[2] Ibid.

[3] Law number 11.274, February 6, 2006, determines that all six-year-old children be enrolled in fundamental education, which will be nine years long instead of eight, as it used to be.

[4] Impaired students used to attend specific classes/schools. Currently, they are being integrated to regular classes always that possible, as an inclusive action. The purpose is that these students realize they are also capable to learn and interact with the "normal" ones.

The Brazilian Ministry of Education (MEC) has been strengthening partnerships with public and private educational systems (municipal and State levels) and intensifying the dialogue with different societal groups for a collective elaboration, implementation, monitoring and evaluation of policies, programs and projects targeted to strengthen and improve educational services offered.

In an effort to better improve the education offered, the Ministry became concerned with paying closer attention to the need to strengthen scientific and technological education offered in the country. As a response to that the Coordination of Educational Technologies was created in 2008, responsible for conceiving and implementing public policies for the advancement of scientific and technological education in pre-college level, and for integrating and coordinating public, private, and societal efforts to foster education in such fields – so strategic to assure national development, as we will discuss in the coming sections.

2 Panorama of Brazilian Education and Public Policies of the Ministry of Education

Brazilian education is guided by a systemic vision[5] [1], that is, the understanding that the success of each educational stage/level contributes to the success of the next. For instance, higher education has to be prioritized if one wants well-prepared teachers. Based on lessons learned from prior public policies that used to prioritize one educational level in detriment to others, and after several societal debates, it has been decided to assure equal priority and financing to all educational levels. The Brazilian Ministry of Education, guided by this *vision*, has been conducting policies aiming to assist and invest equally in all education levels and learning modalities. Actions cover the following areas: a) Basic Education; b) Higher Education; c) Vocational and Technical Education; and d) Literacy and Continuing Education. Programs and projects implemented in each area harmonize and complement themselves and are designed to make it possible for students to have access to all education levels.

In cognizance of the constitutional collaborative regime with educational systems, the Ministry, by means of its Secretariat of Basic Education,[6] has been making efforts to promote social quality in education. This quality has an inclusive dimension, committed to providing an efficacy that could be translated into effective learning, knowledge democratization, and social inclusiveness. Brazil has been gathering substantial progress in the expansion of educational scholar assistance in all levels and modalities[7]. Actually, enrolments enjoyed a quantitative evolution with the inclusion of 97.3%[8] of children from 7 to 14 years old in school. Currently, Brazil is in course of universalizing access also for students in early childhood education and high school, by means of equitable state financing of each phase of basic education.

[5] Term coined by the current Brazilian minister of education, Dr. Fernando Haddad.

[6] Includes early childhood, primary and secondary education.

[7] Presently, we have two modalities: a) regular education and b) youth and adult education. Thanks to a recent policy, impaired students are being progressively included in regular classes; they used to represent a separate education modality in the past.

[8] Brazilian Institute of Geography and Statistics – IBGE, National Research by Domicile Sample – PNAD, 2005.

Access, though, is far from being the unique challenge. As a matter of fact, results of our *National System of Basic Education Evaluation* – SAEB, reveal that it is mandatory to pay closer attention to education quality – which involves knowledge construction and development of abilities, attitudes and values expected by the end of the school year. Retention, drop out, age-grade distortion demonstrate the urgency of investing and qualifying even more the education offered, as well as of assuring access to all stages and modalities in basic level.

For this purpose, in 2007 the *Brazilian Education Quality Index* – IDEB was launched, in provision of incentives at sub-national level. This index is based on systematic evaluation of how schools are achieving their goals. This indicator is established in a scale ranging from 0 to 10. Using this tool, the Ministry established biannual performance goals for each school and systems until 2022. Currently, IDEB average for elementary level is 4.0 in public schools; while in private institutions the number is similar to industrialized countries, reaching, 6,0. The new index used in its first measurement data from 2005. Two years later, in 2007, it was proved that the joint effort of government and society working for the betterment of education could generate tangible results, as shown in Table 1. Based upon analyses of IDEB numbers, the Ministry offered technical/financial support to municipalities with insufficient indexes. The amount of resources has been defined from adhesion to the so-called *Commitment All for Education* and the elaboration of the *Plan of Articulated Action* (PAR).

Table 1. IDEB 2005, 2007 and projections for Brazil

	Elementary school				**Secondary School**			
	Observed IDEB		**Goals**		**Observed IDEB**		**Goals**	
	2005	2007	2007	2021	2005	2007	2007	2021
Total	3,8	4,2	3,9	6,0	3,4	3,5	3,4	5,2
Public	3,6	4,0	3,6	5,8	3,1	3,2	3,1	4,9
Federal	6,4	6,2	6,4	7,8	5,6	5,7	5,6	7,0
States	3,9	4,3	4,0	6,1	3,0	3,2	3,1	4,9
Municipalities	3,4	4,0	3,5	5,7	2,9	3,2	3,0	4,8
Private	5,9	6,0	6,0	7,5	5,6	5,6	5,6	7,0

In order to enhance this index, the Federal Government proposed, in partnership with society, the so-called *Education Development Plan* – PDE [2], which comprises the Plan of Articulated Actions, and represents an effort involving government, educational systems, private initiative and other societal actors working in partnership to construct basic education with quality and for all. This pathway was chosen because such task is just too large and complex to be achieved individually, hence the entire society should be involved.

The *Plan* sets goals for quality in basic education, contributing for schools and secretariats of education to get organized in assisting students. It also establishes a basis on which families can have support to require education with quality. The *Plan* also foresees accompaniment and advisory to municipalities with low educational indicators. It also comprises investments for qualifying educational managers and

other basic education professionals, evaluation of offered education; consolidation of mechanisms for social engagement in education, such as school councils; as well as actions to strengthen of scientific and technological education.

As a matter of fact, PDE represents advancement in Brazilian public policies for education, in the sense that in works with effective mechanisms of integrating societal efforts to construct collectively the desired education. This *Plan* makes it possible that the Ministry of Education work along with society to construct and consolidate education with quality and inclusive, in the scope of a systemic vision.

3 Scientific and Technological Education for Sustainable Development

Education for the 21st century presents novel and complex challenges for everyone. Teachers and students are faced with demands of living in a societal fabric characterized by globalization, social inequalities, changes in the traditional family structures, diversity, the influence of media – TV, internet, inclusiveness of impaired students, changes in the labor market, just to mention a few. Productive process has been acquiring high complexity, so that quality and permanent learning becomes mandatory [3].

Science and technology sectors are fundamental to sustainable development of nations (Waack and Amoroso, 2005). Since the Industrial Revolution, scientific and technological advancement has been contributing to generate different levels of development amongst nations [4].

In order to assure higher levels of development in science and technology, national governments have been adopting several strategies to maintain and enhance their level of autonomy and competitiveness in these sectors. One such strategy refers to the elevation of citizens' proficiency in science and technology, by strengthening science and technology taught in schools. In fact, scientific and technological education plays an important role in the preparation of citizens considering that society, mainly from the 20th century on, has been permeated by processes, products and services that require of all individuals a certain level of scientific/technological literacy for effective social inclusiveness (Reis *et al*, 2008). Preparation of professionals in such sectors constitutes also a high priority.

Education in science and technology hence plays a vital role in this panorama. Success of the teaching/learning process of science and technology challenges students, educators and policy-makers worldwide. The integrated understanding of sciences as part of everyone's life has not been achieving the expected results. This is partially demonstrated by national and international standardized evaluations applied to students, such as the Programme for International Student Assessment – PISA [5], which shows that many pre-college students worldwide have not been learning these subjects as they were expected to.

Certainly it is also correlated with both global literacy processes starting during or before elementary education, as well as with intra and extra-scholarly factors. As for the intra-scholarly factors, teaching methodologies sometimes go far beyond the typical manner that students learn. Education in science and technology also faces challenges correlated to pre-service and in-service teacher training. Moreover, schools do not always offer proper conditions/technologies to the quality of the development of pedagogical practices in these areas.

Knowledge changes extraordinarily fast these days. Science and technology evolves very rapidly. The internet has been revolutionizing the manner individuals interact with information and knowledge and teachers are not always sufficiently prepared to work with students born into a world much more changeable and dynamic than the world of just a couple of decades ago. Currently, students need to access, filter and organize a wide amount of data coming from several sources. Due to the expansion of technologies of information and communication – TICs, the production and distribution of information became more accessible to a larger amount of individuals. Nevertheless, information should be translated into knowledge. The process by which students used to learn in the near past (the paradigm of Industrial Society), linearly, cannot be used successfully in the knowledge society. Today, students should have abilities to navigate the cyberspace and work effectively with new TICs. This cybernetic environment, by its turn, is characterized by being non-linear and non-sequential [6].

It is necessary that schools evolve as students change their manner of interacting with the fast transformation in the world scenario. The pathway to assure success in this change must take into serious consideration constraints, interests and possibilities of all actors involved: students, teachers, educational managers, community, parents, and so forth, in a collective, democratic process of gradually substituting ancient paradigms, concepts, and methodologies for those required for the school of the 21st century.

4 Brazilian Policies for Scientific and Technological Education in Basic Level

Countries that acquired higher levels of socioeconomic development invested in educational programs focused on quality. Evaluation results of education quality have shown discrepancies amongst industrialized and developing countries, and meaningful differences between nations that faced the challenges of scientific and technological sectors and those that did not.

In Brazil, there are several initiatives that contribute to the betterment of scientific and technological education of pre-college students, some of them carried out by government, primarily the Ministry of Education in partnerships with educational systems, the Ministry of Science and Technology, and others by the private sector and other societal actors.

Nonetheless, scholarly education in Brazil should improve its approach in order to adequately meet current demands in this area. Apart from the problems related to initial and continued teacher formation and others intrinsic to curriculum, schools lack the basic structure to scientific teaching and practice. From the 143.631 schools that, in 2005, offered some of the primary school grades: 6% counted with science labs; 12% had computer labs; 15% had internet access; and nearly 23% had libraries. For the secondary schools, the situation is better, but still distant from the ideal conditions to make it possible scientific and technological education with social quality. From the 16.570 schools with secondary education in 2005, nearly 38% counted with science labs; 51% had computer labs; 58% had access to Internet; and 79% counted with libraries or reading rooms [7].