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The Geo-School Project: Local Knowledge on Geosciences for Brazilian Teachers of Basic Education

Celso Dal Ré Carneiro
Associate Professor II
University of Campinas
Brazil

Ronaldo Barbosa
Effective Professor
Ibmec – Campinas SP
Brazil

Joseli M. Piranha
São Paulo State University, UNESP
Brazil

José Roberto Malaquias Jr.
Basic Education Teacher
Secretary of Education
Brazil

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Athens Institute for Education and Research
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The Geo-School Project: Local Knowledge on Geosciences for Brazilian Teachers of Basic Education

Celso Dal Ré Carneiro

Ronaldo Barbosa

Joseli M. Piranha

José Roberto Malaquias Jr.

Abstract

The Brazilian basic school system is currently faced by three challenges, among others, to emphasize local knowledge about the places where the students live, to adopt new teaching methods using technologies of information and communication (TIC) and to strengthen the links between practices of basic school teachers and results of academic research. Local geoscientific knowledge is inaccessible for the majority of the Geography and Science teachers. Deficiencies of textbooks and didactic materials, as well as a poor teacher training, prevent to reach such goals. Therefore, there is a need for enhancing in-service training courses. As a contribution to change this situation, the Geo-School Project provides geologic information, images and maps on a given region to basic education teachers of the disciplines Geography and Science. The project is developed by the authors in modules, each one corresponding to one municipality or region of the São Paulo State (SP), Brazil; each module offers didactic geoscientific materials for classroom use at different education levels. A survey has indicated a great demand of audiovisual devices, but the most important result is that participant teachers recognize that an embracing treatment of environmental dynamics supported by geoscientific knowledge may benefit their lectures. The majority of the investigated schools possess computer networks for pedagogical support and internet access, but the use is far from reaching the minimum acceptable level. As long as the Geo-School Project yields free software tools, it stimulates a widespread use of computers and programs. Teachers and students can perform new roles, in a cooperative way. There is a potential to enhance development of studies focusing on environmental issues and to increase quality of life by improving the awareness of the society on Geosciences.

Keywords: Computers and Education, Geology, Geoscience teaching, teacher training, technologies of information and communication.

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Introduction

Nowadays, the Brazilian basic school system must face many challenges. In this paper we select three: (1) the knowledge about local reality of students is stimulated but there is no simple pathway to do that; (2) teachers and schools are invited to develop teaching methods based on information and communication technologies (ICTs), but developers of ICT resources have not reached an appropriate language to significantly help schools (Demo, 2007); (3) new links and approximations between results of academic research and the teaching practices at basic schools have not been significant yet. The last point is clearly an open question.

A report on 'education for all' in Brazil recognized its "great potential to transform its educational context, as well as to influence an educational change in other countries" (UNESCO, 2015). It should be considered also that the "access to basic education has become almost universal" during last decades.

This paper focuses on basic education, thus comprising the time intervals of fundamental education (ages 6-14) and secondary education (ages 15-18). Stanek (2013) shows that primary and secondary education in Brazil follows currently a 9+3 pattern, what corresponds to an "increase from the previous system, which was an 8+3 structure". The change was done in 2010 "as part of the reforms stemming from the 1996 LDB[1]" (Stanek, 2013).

An official incentive towards a focus on the local reality is defined by a series of official documents of the Education Ministry of Brazil. However, geoscientific concepts are inaccessible for the majority of Geography and Sciences teachers of Brazilian basic education.

In the National Education Guidelines and Framework Law (LDB) of 1996, it is expressed that the scientific-technological knowledge must be learned and mastered by any citizen. To reach this, teaching shall be done "by means of qualified proposed situations, in which the interaction of students and teachers produce contextualized knowledge" (Brazil, 2006, p.105-106). The Curriculum Guidelines of High School (Brazil, 1999, Article 5) define that "learning contents are not ends in themselves but just means to build basic cognitive and social skills, with priority against information by itself".

Currently, the educational results in Brazil are unsatisfactory among the fundamental and secondary levels of teaching when compared to other countries. For example, the mean score of science performance for Brazil in the Program for International Student Assessment corresponds to the 59th position among 65 participating countries (PISA, 2016).

Scientific performance, for PISA, measures the scientific literacy of a 15 year-old in the use of scientific knowledge to identify questions, acquire new knowledge, explain scientific phenomena, and draw evidence-based conclusions about science-related issues. The mean score is the measure. (PISA, 2016).

[1] *Lei de Diretrizes e Bases* [National Education Guidelines and Framework Law] (Brazil, 1996).

One reason relates to an inappropriate academic training of teachers to meet the challenge. Textbooks and many didactic materials available for teachers and students fail to help achieving these goals; the required information and specific knowledge about local reality are not available to school teachers or the traditional textbooks can not consider the reality in which the students and teachers live (Fracalanza & Megid Neto, 2006).

Given this reality, over the past 15 years the Geo-School Project aims to investigate and stimulate the inclusion of Geosciences contents in the basic schools of Sao Paulo State, Brazil. The Geo-School Project is divided in regional modules: each one offers computer-supported didactic materials on Geosciences to classroom use, both for basic and intermediate education levels. The modules begin with questionnaires sent to teachers of public and private schools of basic level education. Each project module aims to introduce innovative computer-based teaching materials. The most recent modules included not only images, pictures and regional geological data about the considered region, but also geological maps. These maps have increased the interest of teachers (Carneiro et al., 2012).

The Geo-School Project is developed by the authors in some municipalities of the São Paulo State (SP) to provide regional geologic information to teachers of the disciplines Geography and Science of basic education. When unpublished reports, photographs, maps and computer resources are delivered to teachers, they are benefited by the undisputable importance of visual language not only for Geosciences teaching (Barbosa, 2003; Carneiro et al., 2007), but for Geosciences as academic disciplines (Potapova, 1967; Frodeman, 1995; 1996; 2001; 2010) as well.

Geosciences Education

When the contents actually offered in schools of some regions of the São Paulo State (SP), Brazil, are compared to the National Curricular Parameters it becomes clear that geoscientific subjects were almost completely ignored or abandoned.

Alvarez Suárez et al. (1993) addresses 30 sociological, epistemological and psycho-pedagogic arguments for reserving more time for Geology teaching in secondary school education in Spain. Campos (1997) indicated that the discipline of Sciences at the fundamental level of Brazilian basic schools is fragmental and too much superficial; it does not allow teachers to describe to the students the world where we live, its origin, evolution and destiny. Almost twenty years after that evaluation, the situation has not significantly changed.

Frodeman (2001) points out Geology as having little attention from the Humanities, particularly Philosophy; the author emphasizes that Geology is a unique science because it provides an unified understanding of planet Earth. The geological knowledge is constructed using analogical reasoning, different scales of time and space, visual intelligence and development of historical narratives. These characteristics make Geology a environment plenty of educational opportunities at all levels of education.

Field et al. (2003) described a trend for engaging students in community-based studies of environmental problems in the USA. The reason is the "recent focus on environmental issues in the geology profession and new national education standards encouraging inquiry-based learning and community outreach". Carneiro et al. (2004) argue that Geoscience subjects at the basic education levels would widely benefit Brazilian people; these authors described a list of reasons for increasing geologic culture in education.

Calonge et al. (2010) present a broad perspective of the dissemination of geological knowledge in Spain. Knowledge resulting from research on Geology teaching reveals that teachers may be invited to explore the "possibilities of geology as attractive educational material and great educational interest" in classrooms.

A focus on local reality stimulates participation of local communities on the debate of environmental subjects. This is because it is necessary to know the regional history and evolution, to protect or to conserve the environment. Geoscience subjects may help increasing not only the awareness about the importance of the knowledge on environmental issues, but they can also introduce people into a deeper knowledge on local aspects of the regions where the students live (Carneiro et al., 2007). It allows to stimulate new insights and to develop a culture of sustainability (Piranha, 2007). This is aligned with the objectives of sustainable development (UN, 2015).

Computers in Education

Once computers have appeared in the business world, they also entered the educational world; different formulas have been investigated to increase the effectiveness of teaching with the support of new resources even before the Internet. Many papers have been published both questioning the practical results of using computers in education (Almeida & Valente, 2011; Dwyer, 2007; Oppenheimer, 1997; Becker, 1992) or to exalt the use of new technologies. Some contributions suggest a real break with traditional education (Horn, 2015; Palloff, 2013; Bates, 2015).

In practice, technological resources in education can be used in countless ways and evolve at a rate far exceeding the pace of schools and teachers. The technology appropriation in schools is a function of educational objectives, pedagogical models and specific conditions that can change from one context to the other; so, there is no simple list to present to teachers and educational managers.

Lanier (2015) considers that the most important question to ask about any technology is how it changes people. For the educational field, this opens a debate about some relationships: student-professor, student-knowledge and connections among schools and the society.

During the last decade there is substantial attention on digital information and communication skills (Siddiq et al., 2016). The European Union has acknowledged Digital Competence (DC) as one of 8 key competences for lifelong learning (Ferrari, 2012). DC refers to many aspects connected to "knowledge, beliefs, attitudes, and values concerning information and communication technology (ICT)"; DC covers "a variety of contexts and new technologies" (Ferrari, 2013).

By using computers and the internet in science teaching, it is possible to acquire and to deal with environmental information not only in the fundamental or secondary education levels but also in higher education. Teaching computer-based tools help students to:

> "learn the subject matter in a better way, as they are provided with a variety of knowledge, and a medium where they can observe the virtual experiments and repeat the same experiments many times if they request. It is expected that computer-assisted applications affect the achievements by students" (Morgil et al., 2005).

The use of computers as a didactic tool enhances the ability of teachers as well as promotes sharing of knowledge. It is important that teachers rethink about their practices in classrooms: this can improve also their relationship with students. This, computers really invite teachers to explore a new world with their students, completely distinct from the time the teachers have graduated (Leu et al., 2004):

Many graduates started their school career with the literacies of paper, pencil, and book technologies but will finish having encountered the literacies demanded by a wide variety of information and communication technologies (ICTs): Web logs (blogs), word processors, video editors, World Wide Web browsers, Web editors, e-mail, spreadsheets, presentation software, instant messaging, plug-ins for Web resources, listservs, bulletin boards, avatars, virtual worlds, and many others. These students experienced new literacies at the end of their schooling unimagined at the beginning (Leu et al., 2004, p.1,571).

Brazilian public policies that favor the introduction of computers in schools seem to rely on the assumption that the use of computers by students would bring significant benefits to the quality of primary and secondary education under any conditions (Brazil, 2007).

At least for the southeastern region of Brazil, strong investments in digital inclusion in basic schools have occurred recently (CGI, 2014). For example, in a region relatively close to São Paulo city, after a research on the availability of computers, almost every state school has its own computer infrastructure, thus reaching a percentage close to 100%. However, many computers and software have not been updated; the risk of sub utilization of informatics labs is therefore very high. Although computers are available to students in schools the internet use is not constant or the access to some sites have restrictions. If, ten years ago, the school did not know what to do with computers, today it does not quite know what to do with the internet.

Buying or renewing software licenses of commercial software can stand out as an economic barrier for public schools, but by the other hand the promising alternative of free software is far from meeting the needs of schools since the user needs technical knowledge to make adjustments (Gentilini, 2013).

The use of computers in schools can have a motivating playful component for students. It defines a positive impact, which creates new challenges (Bizelli, 2013). For teachers, however, new literacies are to be acquired, including:

> "the skills, strategies, and disposition that allow us to use the Internet and other ICTs effectively to identify important questions, locate information, critically evaluate the usefulness of that information, synthesize information to answer those questions, and then communicate the answers to others" (Leu et al. 2004, p.1590).

One possibility linked to Geosciences teaching is that, with the support of computers and the Internet, one can collect information just to know more about the place where he/she lives and to access knowledge about the environment and history; every teacher can use this way to bring the debate into the classroom (NMC, 2012).

Some Results of the Geo-School Project

As stated above, inclusion of Geosciences contents in the Brazilian basic education is highly positive. Together with new educational opportunities offered by computer science this may enhance the development of studies about environmental issues.

The first module-pilot of the Geo-School Project was applied to schools of the cities situated between Jundiaí and Atibaia, State of São Paulo, Brazil. Within this area (see http://www.geo-escola.pro.br), increasing urbanization causes an intense environmental stress due, among other factors, to the proximity of the metropolitan region of São Paulo. The available maps are geologic and geomorphologic maps 1:25.000-scale, and topographic maps 1:10.000. A detailed field survey yielded geological field data, photographs and descriptions of problems caused by urban occupation, disclosing that the fast urban expansion generates intense environmental degradation.

Teachers have recognized in the Jundiaí-Atibaia module the importance of environmental dynamics for their disciplines: this expanded the interest on geoscientific subjects. A survey indicated also a huge demand on the use of audio-visual devices. The following subjects were considered of maximum interest by the professors of the region of Jundiaí-Atibaia (Carneiro & Barbosa 2002): (1) water and hydrologic cycle; (2) natural cycles; (3) natural hazards and (4) fieldwork (environmental studies). Considering these results, a didactic material in CD-ROM (available for download at the site http://www.geo-escola.pro.br) was accompanied by an open-source software for editing didactic sequences. The resulting CD-ROM was tested in classrooms by participants, but few teachers have made evaluations; therefore, reliable data was lost.

The experience of Jundiaí-Atibaia offered basis for a second survey with emphasis on water issues in São José do Rio Preto (SP). A few changes were done to avoid a repetition of bad results. The improvements raised an active participation by almost 80 teachers. A questionnaire was sent to 92 public and private schools of basic level education. 116 professors from 42 schools selected the most important topics from a list of 20 subjects on Geosciences (Piranha, 2006; Piranha & Carneiro, 2006; Carneiro & Piranha, 2006; Piranha & Carneiro 2009). A didactic CD-ROM produced in accordance with teacher prioritization was satisfactory, because participants have started a collective process for spreading Geoscientific knowledge inside their schools, with the help of their colleagues; the process has been called "the geo-school in the school" project. When a partnership between higher education institutions and schools is started, any teacher has more time and space to develop new methodologies (Tardif, 2002).

An "editor of sequences" toolkit allows the teacher and/or pupil to produce their own materials from a bank of images filled by scientific information on the region. The tool is included in the Monte Mor and Cajamar modules. The Monte Mor module integrates local and regional data; it includes educational materials in digital and print media. Basic education teachers received training in practical workshops. They started working on the Geo-School site http://www.geo-escola.pro.br and provided local information about the places where schools are situated. Maps created specially to be used at school was distributed both in print and in digital formats. The group of teachers felt more comfortable to work first on the paper version and then to migrate to computers.

As the Geo-School Project brings out free software tools, it stimulates a widespread use of computers and programs and may introduce new roles performed by teachers and students. The authors have found many examples of practical application of the geological information in classrooms and at the school environment. However, the greater is the acceptance found in different schools, the more difficult is to get a close perception from the teacher's point-of-view of the advantages that can result of the appropriate use of software. The Geo-School Project results showed a need to value what the professor already knows, what he/she thinks and what he/she does, and not to try to dictate norms or to lapse on what the professor would have to know or to make according to external academic points of view (Tardif, 2002).

There is a certain consensus that basic education on sciences should start from phenomena of interest and questions familiar to students, preventing them from excess abstraction. The National Curricular Parameters of Medium-Level Education (Brazil, 1999) includes as one objective of basic education to provide students with an integrated vision of Earth processes. Students should learn how an Earth Science researcher observes, selects, manipulates, describes, elaborates and reflects on hypotheses. This approach allows to develop an idea on the scientific method.

The Geosciences, in this context, help professors to include topics about the region where the students live, awaking them to understand familiar aspects or bringing answers to investigations or curiosities. However, a level of abstraction is required to understand the dynamic interactions between the systems which compose the planet.

We try to compare this use with the more intensive use of other resources, as for example, the didactic book. The advantage for subjects more closely associated to daily activities of students is that they connect them to studies on the local environmental dynamics. Such connection is not however clear of noise, especially if it is considered the very common problem of lack of familiarity of the professor with the geoscience questions that, in fact, affect the community where he/she lives and works. This may be a consequence of the frequent precariousness of his/her initial formation in Sciences (Razuck & Rota, 2014).

Carneiro & Santos (2012) detected that teachers have difficulties to teach content of Geosciences due to insufficient in-service training and a number of factors, including poor academic training, lack of practical field training and conceptual deficiencies. Many teachers licensed on Biology have low training in physical and chemical aspects of the geological processes (Toledo, 2005). Geography teachers do not have the necessary vision of physics and chemistry, and neither time scales from origin of the planet, factors that restrict their understanding of natural dynamics.

Besides mastering content, it is necessary that the subject teacher is able to develop in students the necessary skills for the future professional to act efficiently and effectively in the labor market. This requires establishing connections between the knowledge of natural processes and Earth's history with professional work at the technical level.

The experiences described at the Geo-School site have a purpose of to supply elements extracted from the local reality to professors of a defined region. Fiorentini et al. (1998) addresses that research on teaching-learning methods should not be a control of the teaching work but better they must stimulate ways of thinking and reflections to enable professors to find their proper ways to change attitudes and concepts.

The delivery of data to students and teachers depends on geological databases that should be as complete and as detailed as possible. The development should be finished before starting a Geo-School module by itself. This procedure implies an understanding that the scientific community has a responsibility to help surpassing the distances between what it is taught in schools and what is investigated by universities and research centers. It is necessary to transform and to (re)write the produced technical knowledge as well as to publish it in different channels, driven up directly to teachers. An eventual isolation of the scientists can contribute the professors to feel lost, looking for support – completely absent, by the way – in didactic books.

Popularizing scientific concepts involves dissemination of scientific content towards an eager public, the non-specialists. Educational experience that plans to stimulate the use of scientific divulgation in the context of schools would take in account these elements (Barbosa & Carneiro, 2004), as well as the corresponding risks and challenges. To take advantage from the geoscientific knowledge in teaching-learning depends, therefore, amongst other factors, to improve the capacity of teachers and students to learn from maps, images and photographs. Unfortunately it is not common to see such questions treated by teachers and schools.

A preliminary hypothesis was confirmed by the investigation: results of scientific research on natural resources (water, minerals and soils), and environmental studies generate knowledge, which must be delivered to the society in a systemic way. The school is a privileged place to do this, another good reason to justify effort towards more computer and internet use in schools, despite of the fact that these resources are still discouraged in many Brazilian classrooms.

Final Comments

Computers are useful tools for the diffusion of contents of Geosciences. The Geo-School Project offers free software tools both for teachers and students, thus stimulating a widespread use of equipment and programs; however, ahead of the great expectations of the professors, during the research the complexity of the task was bigger than previously imagined.

By the other hand, any interaction of academic researchers with professors at schools involve complex questions that extends beyond the mere use of scientific popularization and new technologies to change practices of professors of Sciences in basic education.

The central objective of the Geo-School Project is to connect the work of Geosciences researchers with the reality of disciplines of basic education as Sciences and Geography. It can also reach teachers of other disciplines. This is indicated by the São José do Rio Preto module, which helped teachers to take advantage from Geosciences subjects inspired from their local reality.

Computers and maps in this context appear more clearly as technological resources and powerful vehicles of investigation. The approach opens new doors to any teacher work; it goes beyond the project homepage and the formerly CD-ROMs, as it allows teachers and students to explore new concepts and resources in the Web or directly in the field.

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