

Geosciences in professional education: a comparative study between Brazil and Portugal

GLEISE R. BERTOLAZI DOS SANTOS¹, CELSO DAL RÉ CARNEIRO^{2,3}, JORGE BONITO⁴

1 – GEOSCIENCES INSTITUTE, UNIVERSITY OF CAMPINAS, GRADUATE STUDENT, DOCTOR DEGREE. CAMPINAS, SP. E-MAIL: GLEISEBERTOLAZI@IGE.UNICAMP.BR

2 – GEOSCIENCES INSTITUTE, UNIVERSITY OF CAMPINAS, GRADUATE PROGRAM OF TEACHING AND HISTORY OF EARTH SCIENCES, PO Box 6152, 13083-970 CAMPINAS, SP, BRASIL. 3RESEARCHER OF CNPQ. E-MAIL: CEDREC@IGE.UNICAMP.BR

4 – DEPARTMENT OF PEDAGOGY AND EDUCATION, UNIVERSITY OF EVORA APARTADO 94, 7002-554 EVORA, PORTUGAL. CIDTFF RESEARCHER AT UNIVERSITY OF AVEIRO AND CIEP RESEARCHER AT UNIVERSITY OF EVORA, PORTUGAL. E-MAIL: JBNITO@UEVORA.PT

Abstract: Brazil faces educational and environmental crisis that enhance the importance of valuing geoscientific contents in school curricula, especially in basic education. The modality of technical education integrated to high school courses (TEIHSC) open broad possibilities to build an integrated view of nature and of human interference. However, the current situation is one of great fragmentation of contents and diversification of teaching-learning approaches. As a contribution to understand better the national reality, the present project aims to carry out a survey of geoscientific themes present in the Brazilian official curricula of TEIHSC courses and in the curricula of secondary professional education of public schools in Portugal. The distribution of technical schools in TEIHSC teaching modality comprises the states of São Paulo, Rio de Janeiro, Minas Gerais and Espírito Santo and even in the official curricula of federal technical schools situated in these states. This project should discuss curricular convergences and divergences from the background of the following courses: a) Brasil: Agriculture, Surveying, Agro livestock, Environmental control, Forestry, Environment, Mining Oil and Gas; b) Portugal: Environmental Management, Food and Beverage Outlets, Forest and Environmental Resources, Tourism, Environmental and Rural Tourism, Viti winery. The investigation will produce a comprehensive panorama of proposals for including geoscientific contents within this type of school integrative curriculum. The debate should attempt to recompose the basic needs to help citizens for taking well-founded decisions about socioeconomic, political and environmental changes.

Manuscript:

Received: Quadrennial Conference of the International Geoscience Education Organization

Accepted: 10/08/2018

Citation: Santos G.R.B., Carneiro C.D.R., Bonito J. 2018. Geosciences in professional education: a comparative study between Brazil and Portugal. *Terraê Didática*, 14(3):320-325. URL: <http://www.ige.unicamp.br/terraeidatica/>.

Keywords: Earth Sciences, professional training, curriculum, technical schools, Brazil, Portugal.

Thematic line: "Geosciences and Natural Sciences for Basic Education.

1. Introduction

This research is under development in the Graduate Program in Teaching and History in Earth Sciences of the Institute of Geosciences of the University of Campinas, Brazil, in a partnership with the Department of Pedagogy and Education of the University of Évora, Portugal. The objective is to evaluate the approach of geoscientific contents in the curricula of technical education integrated to high school courses (TEIHSC) in Brazil and in the curricula of secondary professional education, of public schools of Portugal. In Brazil, data were retrieved from the official curricula of education secretariats of the states of the Southeast region, as well as from the Federal Institutes of Education, Science and Technology (FIEST).

The initiative should produce a consistent overview of data, allowing a comparison between themes of Geosciences that have been proposed and put into practice in Brazilian and Portuguese education. We seek to find common points and disparities between both public policies, as well

as to identify details of how teachers evaluate the curricula they apply. The authors understand the words Geosciences and Earth Sciences as being synonymous.

The research involves instruments such as questionnaires and interviews, which help to collect opinions from teachers directly immersed in the learning environment and who can offer relevant contribution to rethink the formation of technical professionals and their assimilation by the labor market. The results can offer new curricula guidelines for training young people as technical professionals and citizens, both in Brazil and in Portugal.

2. Methods and Materials

Recent debate about Brazilian and international public educational politics has motivated and yielded a scenario for the research, focusing the content of Geography and Biology subjects that compose the Common National Curricular Base and specific subjects, focusing courses on natural resources. The

basis of this work was retrieved from the current official curricula of technical public schools and FIEST in the Southeast region in Brazil. The same information was retrieved from secondary public schools in Portugal. The curricula is named Integrated Technical Secondary School (ITSS) in Brazil. This modality is provided by the Law n°.9394/96 on the Guidelines and Bases of National Education, already amended by Law n°.13.415/17, article 36-B, item I. In Portugal, the secondary education is defined by the Basic Educational System Law n° 46/86, of October 14, in the most recent version given by Law n°. 85/2009, August 27, article 7, which provides the existence of predominantly life-oriented courses, designated by professional courses.

2.1 Investigated Courses

The Table 1 identifies the courses that compose the researched universe, as based on the curricula adopted by each country (Table 1).

Table 1. Investigated Courses1

Brazil	Portugal
Agriculture	Environmental Management
Surveying	Food and Beverage Outlets
Agro livestock	Forest and Environmental Resources
Environmental control	Tourism
Forestry	Environmental and Rural Tourism
Environment	Viti winery
Mining	
Oil and Gas	

The universe of selected schools and consulted teachers is composed by:

- 81 schools and 503 teachers in Brazil;
- 164 schools and 781 teachers in Portugal.

The disparity shown is a function of territoriality, that is, the geographic area of the Southeast region of Brazil is ten times larger than Portugal; if we use only one of the Portuguese regions, there would be no representative number of schools and teachers for the research. Another important factor that justifies the disparity between the total population of the research is that Portugal counts an expressive number of secondary schools of professional Technician of Tourism, being 98 units spread throughout the country.

2.2 Research Tools and Steps

Besides the survey of the contents of the official curricula of both countries, the following set of steps was developed to achieve the objectives of the work:

1. Bibliographical survey on teaching of Geosciences in TEIHSC or their equivalents in Portugal.
2. Quantitative inventory regarding the universe of teachers who teach the subjects of Geography and Biology, and the specific disciplines of the technical curricular part.
3. Producing and sending a qualitative-quantitative questionnaire to professors of the subjects of Geography and Biology, and specific disciplines of the technical area, aiming to gather information about the main qualities and deficiencies that they recognize in the curriculum.

For a teacher to participate in the research, in Brazil, it is required to get superior authorizations, represented by state education secretaries and directors of each teaching unit. In Portugal, authorization was given a priori by the Ministry of Education, represented by the Directorate-General for Education, but an authorization by the heads of the school units is also required.

The questionnaires were elaborated according to research norms in Social Sciences, using the Likert Scale as a system for recording the collected data and helping synthesise information (Gabriel 2014, Moreira 2009, Vallejo 2010). A qualitative and quantitative data collection tool was used, in which teachers should record their ideas and opinions in a declaratory manner and through multiple choice answers. The instrument was sent to school units by the Brazilian and Portuguese postal services, respectively, in September and October 2017. A search letter was sent to the directors, as well as completion and return instructions of the questionnaires.

3. The need for a systemic view

Every day new sets of challenges arise about the relationship of humanity with the planet. The questionings require investments, professionals and scientists to deal with problems and to seek solutions.

Geosciences are at the root of most of the challenges and initiatives in quality education for this millennium. Based on the studies of 55 education

specialists, one of the skills students should develop in this century is to do research, to apply and interpret data (Dimenstein 2006). A fundamental requisite is to acquire knowledge about world geography. Based on the premise that Geosciences involve knowledge of Geology, Geography, Biology, Chemistry, Physics and Mathematics, today's students should develop an

Organized action that goes beyond the activities of knowing, identifying, classifying, recognizing agents, actors, facts, places and events that describe the Earth in its structural, physical, chemical, biological, human totality. They should develop processes of reasoning, establishment of relations, evaluation and analysis of processes that have been operating on the planet since its formation until today (Santos 2011, p.16).

To achieve this learning, it is necessary to promote "literacy in the natural sciences" (Pedrinaci et al. 2013), which corresponds to an awareness of each individual about the processes that take place in the various spheres that make up the planet. It is desirable that students properly explore this understanding since basic school in order to provide the construction of a systemic view of the Earth.

In Brazil, geoscientific concepts are fragmented between the subjects of Geography and Biology, and between the Transversal Themes in basic education, which includes elementary and secondary education. To develop in students the so-called "literacy in Earth Sciences" should be the basic objective of compulsory education (Pedrinaci et al. 2013).

Literacy in Earth Sciences can be developed by adopting conceptions of various sciences such as Geology, Biology, Physics, Chemistry, Geography, thus allowing Geosciences to articulate and develop a scientific effort to understand how the planet functions and to determine the causes of phenomena (Santos 2011).

The emergence of the so-called global environmental issue is a relevant educational factor and it is by Geosciences (the literacy in Earth Sciences), that the social and the natural components may be connected. Education can unify:

The human society (with its production and consumption, its civilizations, its demographic profile, its states with its geopolitics) with the physical world (the biosphere with its ecosystems, the interaction of the climate with the relief,

with the waters, with the soil, with vegetation) (Vesentini 2009, p. 81-82)

The systemic conception of Earth System Science assists the understanding of terrestrial phenomena as well as helping teachers and geography researchers to perform spatial analysis. Christopherson (2012) brings an interesting definition of the use of systems in Earth Sciences:

Put simply, a system is any ordered and interrelated set of things and their attributes, connected by flows of energy and matter, distinct from the surrounding environment outside the system. Elements within a system may be arranged in a series or interlaced with each other. A system comprises any number of subsystems. In terrestrial systems, both matter and energy are stored and recovered, and energy is transformed from one type to another (Christopherson 2012, p.5).

Systems design brings together interrelationships, flows and transformations; all of them are included in the concept above cited. They are essential concepts to understand terrestrial processes. The complex interactions present on the planet can still be divided into subsystems, according to Christofoletti (1979) and Christopherson (2012).

The holistic view of Earth System offers a relevant contribution in the teaching-learning process for both Geography and Biology, which are disciplines of the secondary school curriculum. The scenario makes Earth System Science an essential knowledge for teacher training in these areas and, therefore, for ITSS students.

4. Results

In general, TEIHSC curricula presents two sets of curricular components / disciplines. It should be emphasized that the curricular temporality of the courses investigated corresponds to the curricular matrices offered up to 2016. The first set comprises disciplines of the National Curricular Common Base (NCCB), which is obligatory, and the second one by disciplines called technical, or of education, according to the educational institution of each state of Southeast region of Brazil, as follows: São Paulo, Rio de Janeiro, Minas Gerais and Espírito Santo.

All the courses have curriculum matrices of three years of daytime teaching, with a total workload varying between 3,200 and 5,280 class

hours, plus hours of supervised internship when there is one. Only one institution, belonging to the Education Department of Espírito Santo, presents the TEIHSC course in Environment with duration of four years, the classes being taught at night.

All the curricular matrices present the subjects of Geography and Biology. The workloads vary from 150 to 360 classhours; the technical / training disciplines of Geosciences ranges from 40 to 160 classhours, distributed, respectively, by one year of the course or along the three years of the course.

The variation results from the autonomy that educational institutions have to compose their curricular matrices, taking into account the course to which they are destined, especially by the school units of the FIEST. The curricular matrices are of a standard character, independent of the school unit and its location, in the case of the courses linked to the State Center of Technological Education Paula Souza (CPS), responsible for professional education in the state of São Paulo. According to the General National Curricular Guidelines for Basic Education in Brazil, Resolution No. 4 of NCE, July 13, 2010 (Brazil 2013, p. 244),

The curricular structuring of the courses, which lead to the achievement of the defined profile, is of free conception and direct responsibility of the educational institution, obeying the National Curricular Guidelines and the complementary norms of the respective education system, in a form allied to the requirements of the educational institution itself, in terms of the respective pedagogical project, and should count on the effective participation of the school community, especially of its teachers (translated by the authors).

The research focuses on the subjects of Geography and Biology, since they are obligatory according to the National Curricular Guidelines for High School (defined by Resolution No. 2, January 30, 2012 of the National Council of Education (Brazil 2012).). The National Curricular Parameters (Brazil 2000) states that the contents of these disciplines are closely linked to Geosciences.

Technical / training disciplines, although receiving numerous denominations, depending on the institution of origin, can be classified into nine groups of studies: hydrosphere (or hydrology), lithosphere, pedology, climatology, cartography, geomorphology, ecosystems, energy sources and environmental management. These courses

comprise a total of 2.4% on average each, of the total hours of the courses, given semiannually or annually.

At the end of a TEIHSC course, young people acquire dual certification, that is, they are able to pursue higher education and qualified for the job market.

In Portugal, technical / vocational secondary education curricula is defined by ANQEP (National Agency for Qualification and Vocational Education, Public Institution) together with the Directorate-General for Education, an organ of the Ministry of Education. A "Training Reference" provided for each technical/professional course is composed by three groups of disciplines: (a) socio-cultural training components; (b) components of scientific training; (c) technological training, consisting of pre-defined short-term training units (UFCD). The total course workload ranges from 3,100 to 3,500 hours in three years, plus a minimum of 600 hours of compulsory training. The group of components of socio-cultural formation include disciplines as Portuguese, Foreign Language, Area of Integration, Information and Communication Technology, and Physical Education, being these components taught in the three years of the course.

The disciplines that make up the group of scientific formation will be diversified according to the subject area of the course, but in general the disciplines of Biology, Physics / Chemistry, Mathematics, Cultural and Arts History and Biology / Geology, also taught in the three years of course. The exception is the course of Tourism Technician that presents as scientific formation Geography, besides Mathematics and Cultural History and Arts.

The STTUs is divided in modules of 25 or 50 hours per specific discipline of technological training. The STTU is classified in the same nine groups used to classify the disciplines of Brazilian curricular matrices.

If the analysis of the contents of the discipline "Area of Integration", there is a compulsory component in the three years of the courses: a thematic diversity between geography, history, sociology, and ecology. Faced with the fragmentation presented by the training references, the authors decided to analyze the subjects of Biology and Integration Area for all the courses, since they are obligatory and of standard content, besides the specific STTUs of each course under analysis. In

general, the content does not exceed 4.5%, 1.0%, and 1.1% of the total course hours, respectively.

As in Brazil, when finishing a technical/vocational secondary course, young Portuguese also acquire dual certification.

5. Preliminary conclusions

Although the research is ongoing, the preliminary results of the comparative study between the legal documentation governing professional education systems in Brazil and Portugal allow us to find clear differences between what is called the “training curriculum”, as follows:

- The total workload of the courses in three years is greater in the Brazilian curricula as well as the total workload of the disciplines investigated,
- The presence of the subjects of Geography and Biology in the Brazilian curricula, obligatory for all the courses during the three years, evidences more scientific content to be developed in class, giving more solid support to the technical disciplines / formation.
- The compulsory NCCB, present in the three years of the course, assists the learning process of the technical subjects / training during the theoretical and practical training of the students.

On the other hand, the Portuguese Professional Education Training Frameworks reveal a contradiction and a minimization of scientific and technological contents, as well as the reduction of the students' workload during the school years. Nevertheless, the contribution of the compulsory internship can be a differential in the practical formation of the students.

It is necessary to emphasize the reduction of time for the development of scientific and technological contents in relation to Geosciences, as well as the development of skills competences foreseen in the Training Reference.

Carneiro & Santos (2012, p. 87) states that

Teaching Geosciences is more than transmitting knowledge about Geology, Geography, Biology, Chemistry and Physics. This organized action goes beyond the activities of knowing, identifying, classifying, recognizing agents, actors, facts, places and events that describe the Earth in its structural, physical, chemical, biological and

human totality. Teaching Geosciences involves the development of reasoning, processes for establishing relationships, assessing and analyzing phenomena that are in constant interaction on the planet, since its formation up to nowadays.

The characteristics of Geosciences teaching pointed above indicate a need of more time for students to deal with science, for the close relationship with the practical development of skills and abilities required by professional courses. A desired integration between the scientific, technical and technological bases would offer to the labor market better prepared professionals to face diverse situations that appear in each of the professions analyzed.

If the jargon “quantity is not quality” is true, in this case the second part of the doctoral research will depend on the direct response of teachers who teach their classes and work with such integrated teaching. This can reveal the level of demand for geoscientific subjects, and the time necessary as well for development of Earth Sciences in the teaching-learning process of students in vocational courses.

Acknowledgements

The authors are grateful to CAPES (Coordination for the Improvement of Higher Education Personnel) for granting the scholarship during the entire period of this PhD and to the National Council for Scientific and Technological Development (CNPq) for a Research Productivity grant to one of the authors (CDRC). We also thank all the directors of the schools that welcomed us and the teachers who answered the questionnaires.

References

- Brasil. Ministério da Educação. *Lei de Diretrizes e Bases da Educação Nacional: Lei n.º 9.394, de 20 de dezembro de 1996. Alterada pela Lei n.º 13.415/17*. URL: http://www.planalto.gov.br/ccivil_03/leis/L9394.htm. Accessed 08.01.2018.
- Brasil. Ministério da Educação. 2013. *Diretrizes Curriculares Nacionais Gerais da Educação Básica*. Brasília: MEC, SEB, DICEI. 562p.
- Brasil. Ministério da Educação. 2012. *Resolução CNE/CEB n.º 2/2012. Diretrizes curriculares Nacionais para o Ensino Médio*. Brasília, MEC URL: http://portal.mec.gov.br/index.php?option=com_docman&view=download&alias=9864-rceb002-12&category_slug=janeiro-2012-pdf&Itemid=30192. Accessed 08.01.2018.

- Brasil. Ministério da Educação. *Parâmetros Curriculares Nacionais do Ensino Médio*. Brasília, 2000. 109p.
- Brasil. Ministério da Educação. *Resolução CNE/CEB n.º 4/2010. Diretrizes Curriculares Nacionais Gerais da Educação Básica*. Brasília, 2010. http://portal.mec.gov.br/dmdocuments/rceb004_10.pdf. Accessed 08.01.2018.
- Carneiro C.D.R., Santos G.R.B. 2012. Ensino de Geociências na formação profissional em meio ambiente no estado de São Paulo. *Rev. Bras. Geoc.*, **42**(Suppl. 1):84-95. DOI: <http://dx.doi.org/10.5327/Z0375-75362012000500008>. Accessed 08.01.2018.
- Christofoletti A. 1979. *Análise de Sistemas em Geografia*. São Paulo: Hucitec. 106p.
- Christopherson R.W. 2012. *Geossistemas: uma introdução à geografia física*. 7 ed. Trad.: F.E. Aquino, I.D. Abreu, J.C. Simões, R.B. Braga, R. Menegat, U.F. Bremer. Porto Alegre: Bookman. 727p.
- Dimenstein G. 2006. *O que os estudantes precisam saber para serem bem sucedidos no próximo século*. Centro de Referência Virtual do Professor CRV. Secr. Est. Educ. MG. URL: http://crv.educacao.mg.gov.br/sistema_crv/index.aspx?ID_OBJETO=30661&tipo=ob&cp=003366&cb=&n1=&n2=Biblioteca%20Virtual&n3=Temas%20Educativos&n4=&b=s. Accessed 08.01.2018.
- Gabriel M.L.D. 2014. Métodos quantitativos em Ciências Sociais. Sugestão para elaboração do relatório de pesquisa. *Desenvolvimento em Questão*, **12**(28):348-369.
- Moreira J.M. 2009. *Questionários: teoria e prática*. Coimbra: Almedina. 563p.
- Pedrinaci E., Alcalde S., Alfaro P., Almodóvar G.R., Barrera J.L., Belmonte Á, Brusi D., Calonge A., Cardona V., Crespo-Blanc A., Feixas J.C., Fernández-Martínez E.M., González-Díez A., Jiménez-Millán J., López-Ruiz J., Mata-Perelló J.M., Pascual J.A., Quintanilla L., Rábano I., Rebollo L., Rodrigo A., Roquero E. 2013. Alfabetización en Ciencias de la Tierra. *Rev. de la Enseñanza de las Ciencias de la Tierra*, **21**(2):117-129. URL: <http://www.raco.cat/index.php/ECT/articulo/view/274145/362238>. Accessed 29.01.2018.
- Portugal. Ministério da Educação. *Lei de Bases do Sistema Educativo. Lei n.º 46/86, de 14 de outubro*. URL: http://www.pgdlisboa.pt/leis/lei_mostra_articulado.php?nid=1744&tabela=leis. Accessed 08.01.2018.
- Santos G.R.B. 2011. *A disciplina Geociências na formação de técnicos ambientais: Prospecção de práticas pedagógicas*. Campinas: IG-Unicamp. (Dissert. Mestr. PEHCT). URL: <http://www.bibliotecadigital.unicamp.br/document/?code=000807040&opt=4>. Accessed 08.01.2018.
- Vallejo P.M. 2010. *Guía para construir escalas de actitudes*. Madrid: Universidad Pontificia Comillas. URL: <http://blog.uca.edu.ni/dinorahmedrano/files/2011/08/Guiaparaconstruircalculadecalidades.pdf>. Accessed 12.07.2017.
- Vesentini J.W. 2009. *Repensando a geografia escolar para o século XXI*. São Paulo: Plêiade. 161p.