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Geoscience in primary and secondary education

Volume 2

International Geoscience and Geoparks Programme

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Geoscience in primary and secondary education

Volume 2

Results of Expert´s Opinion Survey 2018

CREDITS

Ms. Denise Gorfinkiel, responsible for the International Geoscience and Geopark Programe, has supervised this publication, which was coordinated by Mrs. María Frick, consultant for the International Geosciences and Geoparks Program at Regional Bureau for Sciences in Latin America and the Caribbean, UNESCO Montevideo.

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FOREWORD

UNESCO is the Organization from the United Nations that deals with interdisciplinary research, training, education and creation of capacities in Earth Sciences. This long-term institutional commitment responds to the importance geoscientific knowledge has diversity of life and the future of human society.

The Earth sciences contain fundamental responses to the challenges we must overcome in order to preserve our environment and develop sustainability. The growth of the demand of resources such as groundwater, rare elements of the Earth and heavy metals, demands a science that able to act in an ecological way in order to mitigate the effects of the prospecting and the extraction of those resources.

It is also increasingly necessary global knowledge of Earth Sciences to understand the climate processes and provide decision makers with tools to mitigate the impact of global warming. At the same time, it is necessary to have trained citizens capable of fully exercise their rights and comply with the duties imposed by a responsible citizenship.

Since 1972, UNESCO has worked to mobilize global cooperation in Earth sciences, through an international program, where it has developed bridges between different disciplines and scientists from around the world, in order to stimulate cutting-edge research a share scientific knowledge for everybody's benefit. In 2015, these efforts were renewed within the framework of the International Geoscience and Geoparks Program, which is carried out through the existing one and the new World Geoparks Program, which seeks to increase awareness of geodiversity and promote best practices in protection, education and tourism.

In this age of global change, UNESCO's International Geoscience and Geoparks Program is more important than ever. Especially, within the framework of the 2030 Agenda for Sustainable Development, an intergovernmental commitment and an "action plan in favor of people, the planet and prosperity" that includes 17 Sustainable Development Goals (SGDs) that are "of integrated and indivisible character and combine the three dimensions of sustainable development: economic, social and environmental". Education occupies a central place in this new universal agenda and UNESCO, as an organism of the United Nations specialized in education, was entrusted to direct and coordinate these efforts with its associates. SDG 4 seeks to ensure inclusive and equitable quality education and promote lifelong learning opportunities for everyone. To do this, among other goals, it is proposed to ensure that all students acquire the theoretical and practical knowledge, necessary to promote sustainable development through knowledge of Geosciences and Environmental Sciences (SDG 4.7).

To achieve this goal, the Regional Bureau for Sciences in Latin America and the Caribbean, headquarters of the Geoscience and Geoparks Program for the region, has developed the project: "Building a community vision for Geosciences education in Latin America and the Caribbean". Its objective

is to carry out a first exploratory analysis of the capacities, needs and opportunities of the region in education in earth sciences.

We truly appreciate the support and time dedicated by all the experts of the region who participated in the survey that – although exploratory and preliminary- will help to develop a vision of the community for education in Geosciences and to chart the way forward in our actions of cooperation in the field.

We consider that this is the first step of a long road that we will undertake together to promote and guarantee sustainable development in the region.

Dra. Lidia Brito
Director
UNESCO's Regional Bureau for Science
in Latin America and the Caribbean
UNESCO Montevideo

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Introduction

Objectives

The Project "Building a community vision for Geosciences education in Latin America and the Caribbean" it's an initiative of the International Geoscience and Geoparks Programme of the UNESCO Regional Office for Science in Latin America and the Caribbean. The project supports the development of geosciences in order to help countries to develop and contribute to sustainable development, taking into consideration priorities such as mineral resources, energy, water resources, and geological risks. Its objective is to make a diagnosis of the capacities, needs and opportunities of the region regarding the teaching of Earth Sciences at primary and secondary education levels that can help develop a vision of the community and trace the path to continue for national policies and international cooperation in this field.

This second volume emphasizes the following educational topics:

- Policies, strategies and Geosciences education promoting programs
- The level of inclusion of Geosciences in the curricula and textbooks of teaching.
- The characteristics of the trainings for teachers in Geosciences
- The evaluation mechanisms of learning in Geosciences.
- The Institutional experiences and transformative pedagogies inside and outside the classroom.

Institutional Alliance

The Project "Building a community vision for Geosciences education in Latin America and the Caribbean" has been implemented through a strategic alliance with the International organization of Geoscientific Education (IGEO).

In order to achieve these objectives, In order to meet these objectives, IGEO monitors the teaching of Geosciences at an international level and encourages communications between educators from around the world.

Methodological approach

As mentioned already, the Project was developed in two complementary phases that were executed simultaneously; the results of which are presented in this publication. In this second Volume, we present the implementation of a survey with the opinion of experts, which allows generating comparative information that complements the opinions expressed by the experts in their country reports.

This publication was articulated around identical thematic axes for the different levels of education: general curricular situation, evaluation of learning, teacher training and solvency and material support for the development of Geosciences topics.

As a result of these actions, high-level experts were identified in 16 countries of Latin America and the Caribbean, who participated in the survey. Also, representatives of IGEO within 35 countries from other regions, who participated in the exercise in order to provide similar information for their respective countries and regions. It is worth mentioning that the participation of men and women occurred in the same proportion.

In all cases, the participation of the experts was voluntary and had their authorization for the publication of the results. The coordination of the different phases of work was carried out from the UNESCO Regional Science Office for Latin America and the Caribbean, based in Montevideo.

Quantitative survey

In this volume, Chris King, IGEO Advisor, and Denise Gorfinkiel, responsible of UNESCO's International Geoscience and Geoparks Program, present the results of the opinion survey did to the experts in Earth Sciences education in the countries of other regions of the world and of Latin America and the Caribbean.

This survey was based on the survey implemented by IGEO since 2000, which was expanded in 2006 and later updated in 2012 and 2013. During 2016 a team of representatives of UNESCO and IGEO worked on the reformulation and expansion of this form to ensure it was an instrument capable of adequately identify the current capabilities, needs and opportunities of teaching Earth sciences in basic (primary and secondary) education in the different countries and educational systems.

This survey (see Appendix) was presented in order to be discussed in workshops organized in the framework of the different international events, with the purpose of collecting observations and validating its structure and general objective. To be known: rd Latin American Congress of Research in Science Didactics (organized by the Latin American Network of Researchers in Didactics of the Sciences, July 6-8, 2016, Montevideo, Uruguay), 10th International Earth Science Olympiad (organized by IGEO, August 20-27, 2016, Mie, Japan), and 35th International Geological Congress (organized by the International Union of Geological Sciences, from August 27 to September 4, 2016, Cape Town, South Africa).

Although a single response was foreseen per country, in Latin America and the Caribbean, national experts had the opportunity to complete the forms together with colleagues, academics, teachers and interested stakeholders in the subject (see the list of experts participating in the Appendix). For this, they used different modalities, from the implementation of the survey at a national level (taking the average of the data as the final answer) or the organization of workshops in order to discuss and complete the form in person.

These modalities allowed an intersectional and open dialogue about an issue of common interest, while it also generated new opportunities of collaboration at a local level.

Scope of results

The results of the two phases of the work integrate this publication. It must be emphasized, however, that the results have an intrinsic bias that arises from the fact that all the participating experts - both in the analysis by country and in the survey- are people with experience and / or interest in the teaching of Geosciences.

This means, first of all, that the participation of the countries depends in general of the will and interest of experts to participate, beyond the efforts made by the different governments to strengthen the teaching of Earth Sciences in primary and secondary education.

But it also implies that there is some personal experience and perceptions already formed by the experts who complete the questionnaires - from Earth Science professors to heads of University Geoscience Departments and from teacher educators to government officials.-

It should also be considered that in all cases the opinion expressed by the experts surveyed and by the authors of the different texts does not necessarily represent the position of UNESCO, but rather reflects their experience and academic work in the area. Nor does it necessarily represent the opinion of its institutions or countries of origin.

Consequently, it should be emphasized that in all cases the information collected is partial and exploratory. In this sense, far from allowing a definitive diagnosis, these data helps to delineate a state of affairs that should be studied in greater depth. Although it is considered that the complementary of the methodologies used in the two phases allows a more complete view of the situation of Earth Sciences in the region, it is not intended to generalize or go beyond the strict interpretation of the information given.

For this reason, this study talks about trends or aspects of greater prominence, without these expressions being understood as a generalization of was occurs in the region. However, and with the due care already mentioned, the comparison of the information gathered in both phases allows us to visualize a regional map with the main curricular characteristics of Earth Sciences.

Earth science education across the globe

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Chris KING Chair
Commission on Geoscience Education, Training and Technology Transfer (COGE),
International Union of Geological Sciences (IUGS),
Advisor, International Geoscience Education Organisation (IGEO),
Professor Emeritus, Keele University, United Kingdom.

Background

When the International Geoscience Education Organization (IGEO) was first formed in the year 2000, one of its priorities was to establish the distribution and scope of Earth science education across the world and so a survey was carried out amongst IGEO members.

A second survey was undertaken in 2006 jointly by IGEO and the International Union of Geological Sciences Commission on Geoscience Education and Technology Transfer (IUGS-COGE).

In 2012, the IUGS hierarchy invited IGEO/IUGS-COGE to write up the results of the 2006 survey for publication. It seemed sensible at that stage to invite all those countries that had provided data for the second survey to update their data for 2012. The opportunity was also taken to invite new countries to participate, through both IGEO and IUGS. The third survey therefore included all the 2012 data together with data from the 2006 survey from countries that were not able to update their data.

Each of the first three IGEO surveys sought a response to the overarching question of, 'How does school-level Earth science education compare across the globe?' through a series of sub-questions. The first survey acquired data from 21 countries, the second from 27 countries, and the third from 32 countries. The results of this third international survey were analyzed and published and are currently available on the IGEO website[1].

The 2013 survey concluded: the data from the ... sample of the 32 counties included in the survey can be summarized as follows.

- Curricula- across the world: Earth science is included in science and geography curricula in a variety of different ways.
- Standards: most countries have national standards for Earth science.
- Global coverage: there is good coverage of Earth science in the school curriculum globally – particularly for 7 – 16-year-old.
- Textbooks: more than half the textbooks for elementary students and more than a third of textbooks for high school students are of poor quality or are not available.

Overall, the data indicates that most global developments in Earth science education at school level have been driven by enthusiastic individuals and groups. This being the case, it is not surprising that global development is very patchy. Nevertheless, a general improvement is probably discernible.

The current survey, entitled, 'Experts survey on geoscience education: approaching Earth Sciences in primary and secondary education' is the fourth international survey of geoscience education. It was jointly conducted by UNESCO International Geoscience and Geoparks Programme, at Montevideo Office –Regional Office of Sciences in Latin America and the Caribbean, and the IGEO, with the support of the International Union of Geological Sciences Commission on Geoscience Education and Technology Transfer (IUGS-COGE). The survey was undertaken between the months of May and September 2017.

Introduction

The focus of UNESCO was to survey school-level geoscience education in as many Latin American countries as possible, whilst IGEO with IUGS-COGE support was able to expand the survey to include 35 more countries across the globe. Representatives across the world

1 More information: http://www.igeoscied.org/activities/geoscience-education -survey

were invited by IGEO and IUGS-COGE to participate in the survey by submitting a brief Curriculum Vitae and providing their institutional backgrounds. Some countries had an individual contributor whereas small teams of contributors were involved for some countries.

Experts from 35 countries responded to the international part of the expert's survey (see Table 1). 77% of the respondents were members of the IGEO whilst 20% were Commissioners of the IUGS-COGE; some were members of both organisations.

The profile of those responding to the survey indicated that 80% of the contributors held Doctorates, 17% held master's degrees, and an additional 3% held bachelor's degrees; 51% were male and 49% female. 60% of those responding was from universities, 17% from research centres, 9% from National Ministries, 9% from schools. These data illustrate the breadth of expertise that was applied to completion of the survey.

Table 1. The list of countries covered by the survey, excluding Latin American countries covered elsewhere.

Latin America and the Caribbean	Other regions		
Australia	India	Namibia	Sri Lanka
Bulgaria	Indonesia	New Zeeland	Turkey
Canada	Iran	Norway	United Kingdom
China	Israel	Pakistan	United States
Denmark	Italy	Philippines	Zambia
Egypt	Japan	Portugal	
Finland	Kyrgyzstan	Russia	
France	Malawi	South Africa	
Germany	Mauritius	South Korea	
Greece	Mongolia	Spain	

General Policies on science Education

The survey respondents were asked to give their opinion on the national policies on science education. According to experts from the 35 countries surveyed, in 86% of 30 countries, cases there is a range of national policies to raise the profile of science in education, with only five countries indicating no such national policy developments. In most of the cases (67%), these policies are not framed within supra-national strategies, whilst there is a coordinated approach at national and sub-national level (77%).

In 63% of 19 countries, cases the experts mentioned that national policies have measurable objectives for implementation and follow up, as a means of monitoring the development of past and current policies. Performance of policies is evaluated with independence from the Ministry/Education Agency and with a variety of stakeholders in 63% -19 countries-, while results and evaluation reports are published in 67% (20 countries).

In general, the principal types of national policies implemented include:

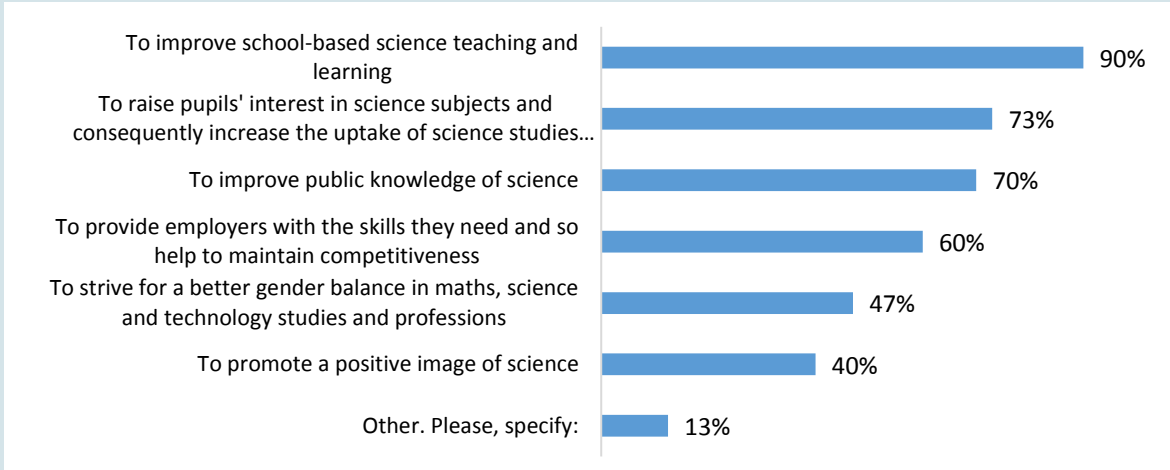
- General policies encompassing all stages of science education and training (66%);
- Policies or programme documents focusing on stages of education and or specific areas of learning (49%);

- Broad strategic framework document to raise the profile of science in education and wider society (43%);
- Individual programmed documents and projects (such as school partnerships and science centers) with a science guidance purpose (40%); and
- Other types of instruments (14%).

The main reasons given for such policy developments are: the rising demand for qualified researchers and technicians (70%), and the concern that there may be a decline in innovation and, consequently, economic competitiveness (63%). However, other reasons include the declining in science studies and related professions (43%) and unsatisfactory results in international educational performance surveys (40%).

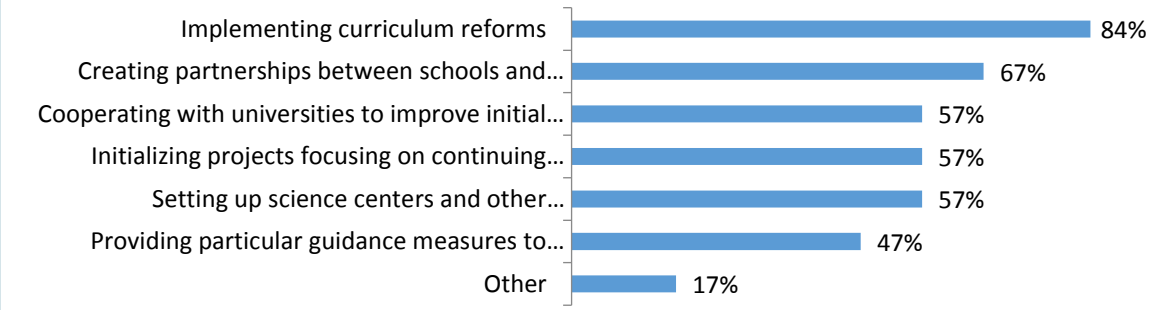
Expert´s opinions on the main broad educational goals of the national policies are shown in Graphic 2. In most cases, their main aim is to improve school-based science teaching and learning, 90%, 27 countries, whilst the raising of pupil´s interest in science subjects and the up taking of science studies at secondary and tertiary education, 73% of 22 countries, the improvement of public knowledge of science -70% of 21 countries- and are in the second and third place. In fourth place, are: to provide employers with the skills they need and so help to maintain competitiveness -60%, 18 countries-, to strive for a better gender balance in math, science and technology studies and professions -47%, 14 countries-, and to promote a positive image of science -40%, 12 countries-.

Graphic 2: Main educational goals of national policies to rise the profile of science in education (Expert´s opinion, non Latin-American countries, n=30)



As shown in Figure Graphic 3, results indicate that governments are attempting to implement different approaches to achieve these goals. Although results show the main lever for the development of science education across the world is curriculum reform -83%, 25countries-, a range of other strategies is also being implemented. Among them: the creation of partnerships between schools and companies, scientists and research centers -67%, 20 countries-; the improvement of initial teacher education in cooperation with universities -57% of 17 countries-; initializing projects focusing on continuing professional development for teachers, 57%, 17 countries; the setting up science centers and other organizations, 57% of 17 countries. In 14 countries -47%- there is also the provision of guidance measures to encourage more young people to choose scientific careers -44%-.

Graphic 3: Main approaches to implement national policies rise the profile of Science in education (Expert´s opinion, non Latin -American countries, n=30)



Primary Education: Natural Sciences Curriculum, assessment & teaching

Experts reported that 19 (54%) of the 35 surveyed countries have a compulsory national curriculum for primary education that covers Natural Sciences, whilst a further 6 (17%) have national standards or guidelines covering this field. Only 6 countries (17%) have no national curriculum covering Natural Sciences at the primary level, whilst in 4 of them (11%) the curricula or standards are implemented at a sub-national (regional) level -Canada, Germany, India and United States-.

According to the results, most of the 25 countries that have national curriculums or standards covering Natural Sciences, implement their primary science curriculum from 1st grade/year the 6-7-year olds, -60%, 15 countries-, some from 2nd grade/year the 7-8-year olds, -12%, 3 countries- and some from 3rd grade the 8-9-year olds, -20%, 5 countries-. In 88% of the cases, 22 countries, curriculums or standards are provided by the National Ministry of Education.

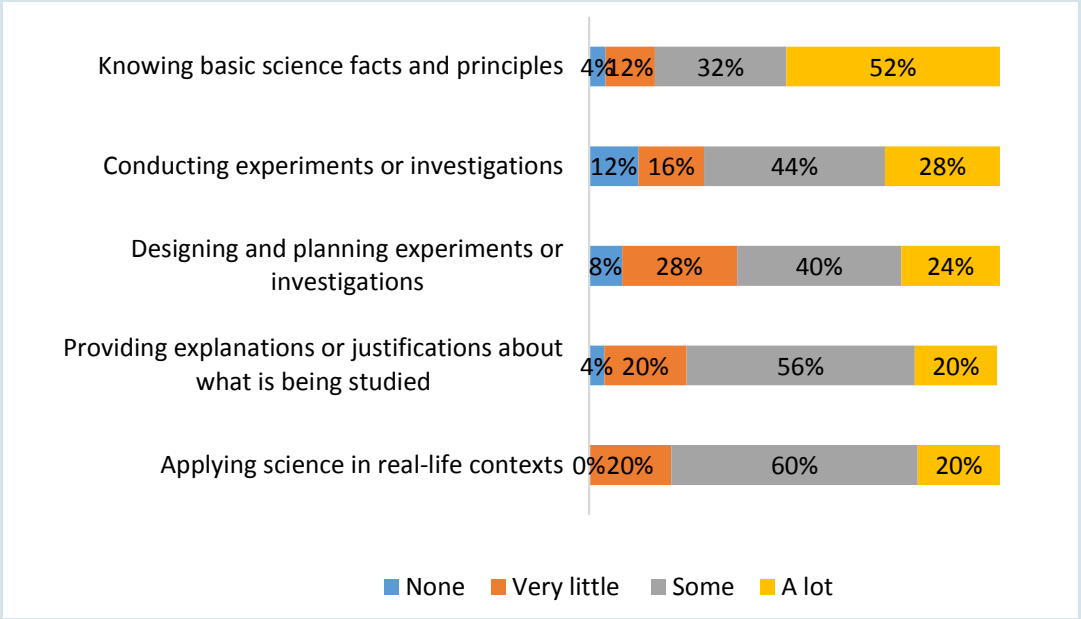
The national curricula prescribe goals and objectives -88%, 22 countries- and instructional processes or methods -60%, 15 countries-, and most prescribe materials such as textbooks or assessment methods -52%, 13 countries-. More than half of the primary science curricula prescribes the amount of instructional time to be devoted to Natural Sciences -60%, 15 countries-. In the responses from some countries, primary science teaching time is given as a percentage, and in some as several hours, whilst in others, it is different at different grades; however, the mean for those countries reporting percentage of curriculum time devoted to primary science is around 17%, ranging from 10% to 30% (n=9).

Graphic 4 highlights expert´s opinion on the main emphases of Natural Sciences curricula in primary education of the 25 countries that have national curriculums or standards. This figure shows that 52% -13 countries- gives "a lot" of emphasis to the knowledge of basic science facts and principles, whilst 60% -16 countries- gives "some" focus on applying science in real-life contexts. The emphasis that emerges as the least applied -12%, 3 countries- is conducting experiments and investigations.

Regarding student's assessment, expert's responses indicate that, in 60% -15 countries- of the 25 countries that have national curriculums or standards, the curriculum or standards provide guidelines for Natural Sciences assessments. In those cases, the most commonly used techniques are: traditional written and oral examinations -87%, 13 countries, but student´s class performance -67%, 10 countries- and project-based work -47%, 7 countries- are also important. Fieldwork is endorsed in 2 cases the 13%.

In most of the 15 countries in which the curriculum provides guidelines for Natural Sciences assessments, student knowledge and skills in Natural Sciences are addressed through standardized procedures at the national -12 countries- or international -7 countries- levels, being compulsory in 9 countries for the national level and in 4 for the international one. In 81% -12 countries- of the countries, student assessment data is mainly used for student evaluation, in 47% -7 countries- for state-

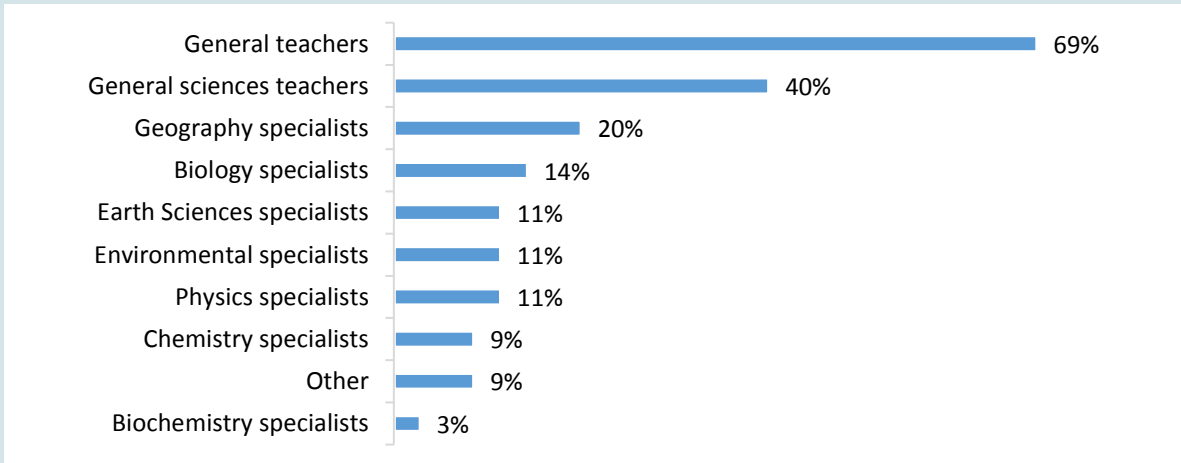
Graphic 4: Main emphases of the Natural Science curricula for primary education (Expert´s opinion, non Latin-American countries, n=25



wide monitoring, 47% -7 countries- for accreditation systems, and 40% -6 countries- for teacher appraisal.

Experts from all the 35 surveyed countries provided their opinion on the teaching of Natural Sciences at primary level. Around two thirds of the country's -66% of 23- do not have teachers who teach only Natural Sciences during primary education. Most science teachers are general teachers -69%, 24 countries- while fewer than half are general science teachers -40%, 14 countries-; a fifth are Geography specialists -20%, 4 countries- whilst others have other science specialisms (see Graphic 5)

Graphic 5: Profile of Natural Sciences teachers at primary level (Expert´s opinion, non Latin-American countries, n=35)



In general, primary teachers are trained through university degree -66%, 23 countries- and teacher college programmes -54%, 19 countries-; 29% -10 countries must pass a qualifying exam, whilst others complete a probationary teaching period or a mentoring or induction program -31%, 11 countries-. Other support available to teachers of primary Natural Sciences across the 37 countries surveyed includes:

- Specific continuing Professional Development (PD) activities provided by education authorities in official training programmes for in-service science teachers -74%, 26 countries-;
- Public policies for the promotion of science education that include the improvement of science teacher education -71%, 25 countries-;
- National initiatives focusing on the initial teacher training of science teachers -57%, 20 countries-;
- School partnerships, science centres and similar institutions that contribute to teachers' informal learning and provide advice -51%, 18 countries-;
- Science centres that deliver formal continuing professional development (PD) activities for teachers -37%, 13 countries-; and
- Teacher education programmes that address dealing with gender (i.e. considering the different interests of boys and girls and avoiding gender stereotypes when interacting with students) -31%, 11 countries-.

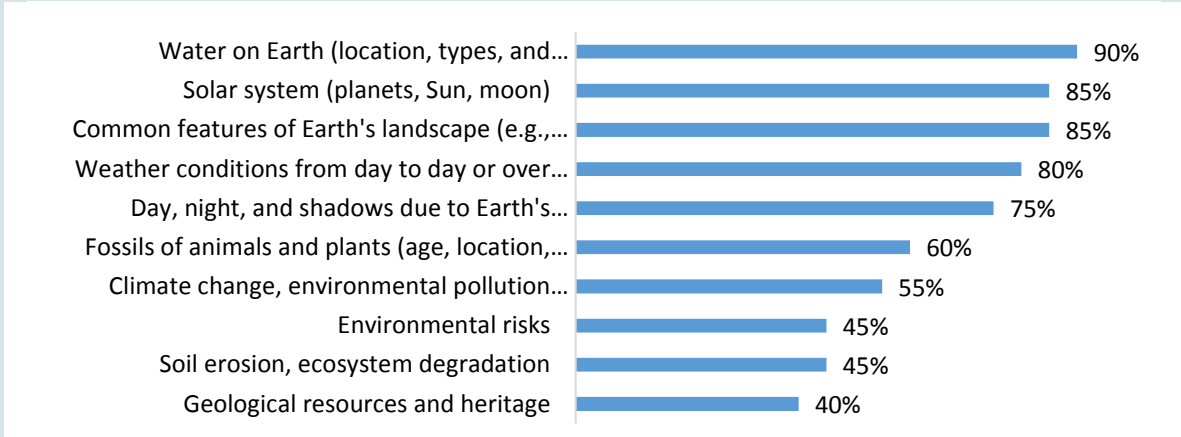
Earth Science at Primary Level

As experts indicate, from the 25 countries that have national curriculums or standards, 20 countries -80%- have Earth science in their primary curriculum whilst 5 -20%- countries do not. In the opinion of the respondents, the primary Earth science curriculum is followed very closely or quite closely in only 55% -11 countries- of countries; in 40% -8 countries- of countries they feel that the curriculum is not closely followed and in one country -5% of sample-, it is largely ignored.

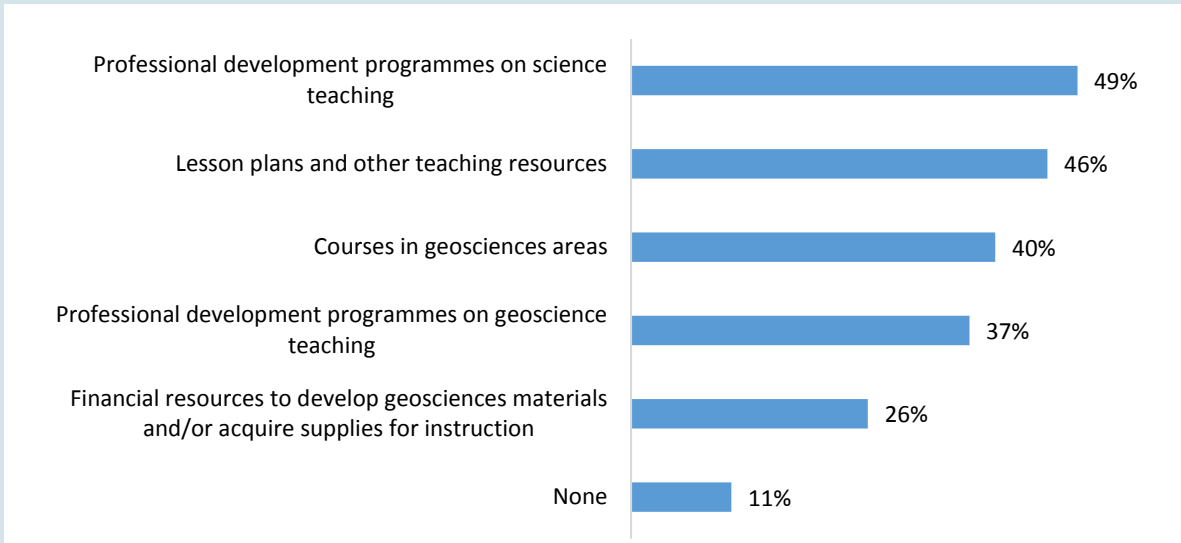
The topics covered by primary Earth sciences indicated by the 22 responses are shown in Graphic 6. This figure indicates that *Water on Earth and air* -90%, 18 countries-, and *Solar system* and *Common features of Earth's landscape* -85% or 17 countries, each- and *Weather conditions* -80%, 16 countries-, play key roles in the primary Earth science curriculum, as does *Day, night, and shadows* -75%, 15 countries-. In around half the countries (11), *Climate change, environmental pollution*, *Fossils of animals and plants*, and *Environmental risks* are also covered. *Soil erosion* and *Geological resources and heritage* are studied in fewer countries -8 to 10 countries- but are still covered in more than a third of the countries which responded to the survey.

According to the results, of the 12 countries that have national standardised procedures for student´s assessment in the Natural Sciences, 6 indicated that specific questions about Earth sciences are included. In another

Graphic 6: Topics taught by the end of primary education according to the curriculum (Expert´s opinion, non Latin-American countries, n=20)



Graphic 7: Support given to primary teachers for their teaching of Earth science topics (Expert´s opinion, non Latin-American countries, n=35)



6 countries, these tests include general questions about *Physical Sciences in general, including Chemistry, Physics and Earth Sciences*. In just 1 country, there are questions about *Natural Sciences in general*. This is like the case of the 7 countries that participate in international national standardised procedures for assessment in the primary Natural Sciences: 3 indicated that specific questions about Earth sciences are included; 4 indicated the inclusion of general questions about Physical Sciences in general, including Chemistry, Physics and Earth Sciences; and 1 country indicated there are questions about Natural Sciences in general.

Finally, the survey gave information about the preparation and support given to teachers for the teaching Earth Sciences topics in primary education. As Graphic 7 shows, experts from the 35 surveyed countries indicated that in almost half of cases teachers have access to *professional development programmes in science teaching* -49%, 17 countries- and *lessons plan and other teaching resources* -46%, 16 countries-. However, in fewer cases did they have access to *courses in geosciences areas* -40%, 14 countries- and *professional development programmes in geoscience teaching* -37%, 13 countries-. *Financial resources to develop geoscience materials and/or acquire supplies for instruction* is indicated to be available in 9 countries -26%-. In 4 countries teachers have no or very little support for their Earth Science teaching.

In 26 -74%- of the 35 countries teaching materials are available for the teaching of Earth sciences at primary level. However, the general view of the reviewers is that the quality of the teaching material provided, where available, is only moderate and 14% is poor, with only 9% -3 countries- having high quality Earth science-teaching material available.

Lower secondary education: natural sciences curriculum, assessment & teaching

The questionnaire responses reported that 21 (60%) of the 35 surveyed non-Latin American countries have a compulsory National Curriculum or Programmed covering Natural Sciences, with a further 7 (20%) that have national standards or guides covering this field. 3 (9%) countries have a Natural Sciences curriculum or standards implemented at sub-national -or regional level, Canada, Egypt India and Germany- whilst only 4 (11%) have no national science curriculum covering science teaching at lower secondary level.

As stated by experts, most of the 28 countries that have national curriculums or standards implement their lower secondary science curriculum or standards from 1st

grade/year -86%, 24 countries-, whilst 2 implement it from 2nd grade/year and some from 5th grade, respectively. National science curricula or standards are provided by National Ministries of Education in 22 countries (79%), while in the rest of countries it is provided by National Agencies and federal ministries.

Among the 28 countries that have a national curriculum or standards covering Natural Sciences, 26 (93%) give goals and objectives, 18 (64%) cover instructional processes and methods and 15 (54%) specify instructional materials and/or assessment. In 17 countries (61%), the curriculum documents prescribe the percentage of time to be devoted to Natural Sciences. Where an amount of time is specified, this may be in numbers of hours, nevertheless, where percentages were given in the responses (n=11) the mean amount of time was 21%, ranging from 10% – 40%.

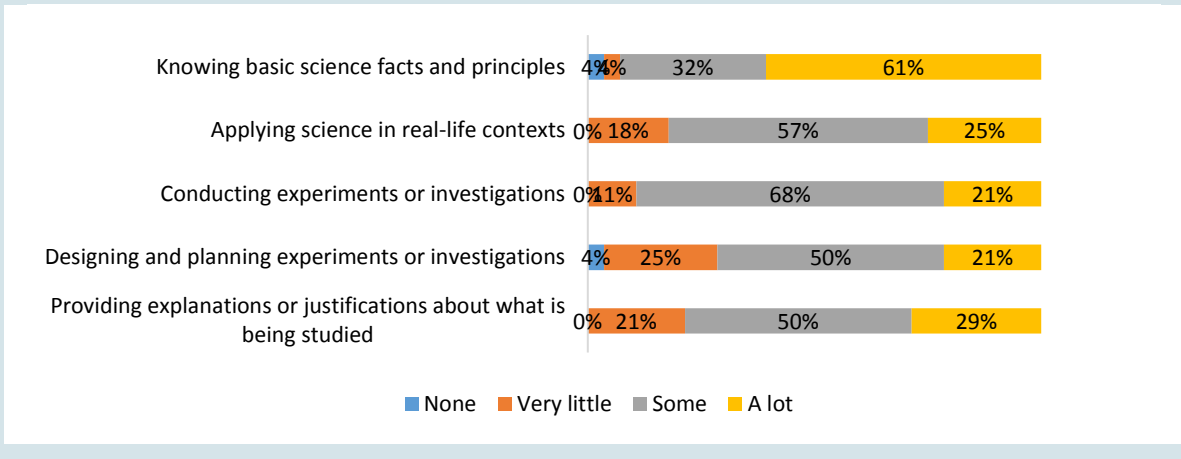
Figure Graphic 8 highlights expert´s opinion on the main emphases of Natural Sciences curricula in lower secondary education of the 28 countries that have national curriculums or standards. This figure shows that that many countries give *a lot* -61%, 17 countries-or "some" -32%, 9 countries- emphasis to the *knowledge of basic science facts and principles*. Most of them also give *some* -50%, 14 countries- or *a lot* -21%, 6 countries- of emphasis to *designing and planning experiments or investigations*. 57% -16 countries- give some emphasis to *applying science in real-life contexts* and 50% -14 countries- to "providing explanations or justifications about what is being studied".

Graphic 8 also indicates that, whilst the strong emphasis on scientific facts and principles continues from primary science (Graphic 4), there is slightly more emphasis on providing explanations and justifications than in primary science. At lower secondary level, all curricula require pupils to conduct experiments and investigations, and nearly all require the design and planning of investigations.

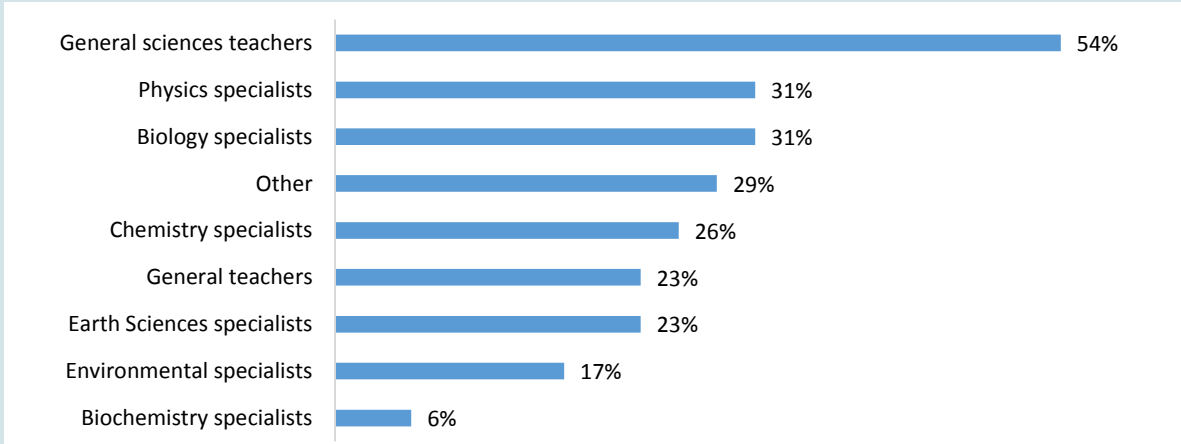
Regarding student's assessment, expert´s responses indicate that of the 28 countries that have a lower secondary school science national curriculum or standards, in 18 (64%) countries there are guidelines for the assessment in the Natural Sciences. In most of these countries, most commonly used methods for student assessment are traditional written/oral examinations -94%, 17 countries- and students' performance in class -89%, 16 countries-, followed by project-based work -72%, 13 countries- and fieldwork -22%, 4 countries-. As at primary level, the strong emphasis is on examination, but class performance is also very important and project-based assessment retains a high profile. As at primary level, fieldwork-based assessment is unusual.

Among 14 (88%) of the countries in which the curriculum provides guidelines for Natural Sciences assessments, there are national tests – which are compulsory in 11 of the cases. International tests are used in 10 countries, being compulsory in 6 of them. In 67% of these 18 countries, student assessment data is mainly used for student evaluation, in 61% for state-wide monitoring, 50% for teacher appraisal, and 44% for accreditation systems.

Graphic 8: Main emphases of the Natural Science curricula for lower secondary education (Expert´s opinion, non-Latin American countries, n=28)



Graphic 9: Profile of the Natural Sciences teachers at lower secondary level (Expert´s opinion, non-Latin American countries, n=35



Experts from all 35 surveyed countries provided their opinion on the teaching of Natural Sciences at lower secondary level (Figure Graphic 9). In 22 (63%) countries, there are teachers who teach only Natural Sciences during lower secondary education, of these 14 have implemented specific actions to recruit or retain Natural Sciences teachers for lower secondary education. Most science teachers are general sciences teachers (54%, 19 countries) and Biology or Physics specialists -31%, 11 countries, each- or they have other backgrounds -Chemistry, Environmental studies, etc.-, including Earth Sciences specialists -23%, 8 countries-.

In general, lower secondary science teachers are trained through university degree programmers -80%, 28 countries- and teacher college programmed -46%, 16 countries-. In other countries, they must pass a qualifying examination -26%, 9 countries-, undertake a probationary teaching period -29%, 10 countries) or a mentoring or induction program -11%, 4 countries-.

As the results indicate, the pattern of support available to teachers of lower secondary Natural Sciences is very similar to that available to primary science teachers. They include:

- Public policies for the promotion of science education that include the improvement of science teacher education 77%, 27 countries;
- Specific continuing professional development (PD) activities provided by education authorities in their official training programmed for in-service science teachers -57%, 20 countries-;
- National initiatives focusing on the initial teacher training of science teachers -51%, 18 countries-;
- School partnerships, science center's and similar institutions that contribute to teachers' informal learning and provide advice -43%, 15 countries-;
- Science center's that deliver formal continuing professional development (PD) activities for teachers -34%, 12 countries-; and
- Dealing with gender (i.e. considering the different interests of boys and girls and avoiding gender stereotypes when interacting with students) is addressed in teacher education programmed -17%, 6 countries-.

Earth Science at lower Secondary Level

According to the results, from the 28 countries that have national curriculums or standards for Natural Sciences, 21 countries have Earth science in their lower secondary curriculum (75%) whilst 7 countries do not. In the opinion of the respondents from the 21 countries that have Earth science in their lower secondary curriculum, the curriculum requirements are followed very closely or quite closely in 67%, in 24% of countries they are not very closely followed and in 10% they are largely ignored.

In general, the areas of the curriculum where the Earth science content is found are:

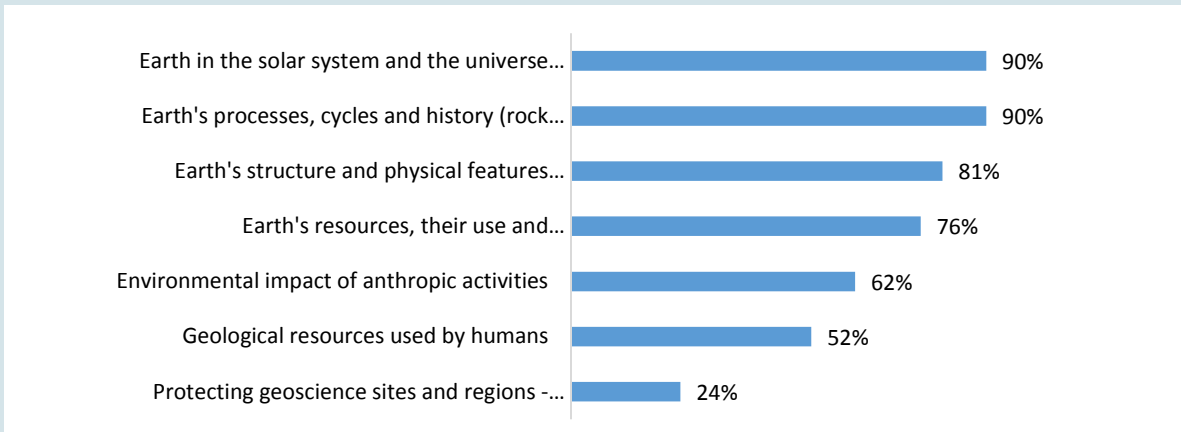
- Geography: 57% -12 countries-;
- Geology, Biology: 38% -8 countries-;
- Earth and Space Sciences, Geosciences, Environmental Sciences: 33% -7 countries-;
- Physical Geography, Earth Science, Earth Sciences, Chemistry: 29% -6 countries-;
- System Earth, Earth Systems Science, Geoscience, Physics, and Integrated science subject: 19% -4 countries-;
- Biochemistry, Ecology, Natural environments and wildlife, Integrated Natural Sciences subject, Crosscutting concepts or core ideas: 14% -3 countries-).

The topics covered by lower secondary Earth sciences indicated by the 21 responses are shown in Graphic 10. According to this figure, equal weighting is given to studies of the *Earth in the solar system and the universe* and *Earth's processes, cycles and history* -90% or 19countries each- and similar weighting is also given to the *Earth's structure and physical features* -81% 17 countries- and the Earth's resources, their use and conservation" -76% or 16 countries-. Human-related aspects have a lower but nevertheless still important, profile: *Environmental impact of anthropic activities* -62%, 13 countries), *Geological resources used by humans* -52%, 11 countries-, and *Protecting geoscience sites and regions - geoscience heritage* -24%, 5 countries-.

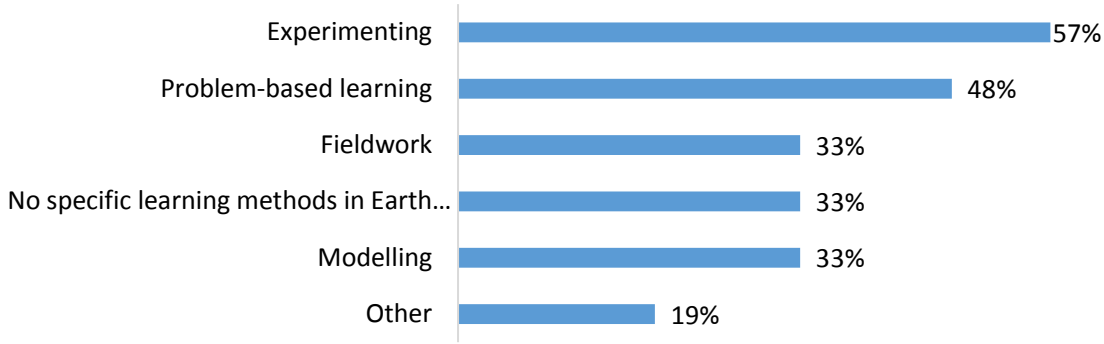
Not surprisingly, these topic areas are more wide-ranging than found in the survey data covering the primary science curriculum (Graphic 6) and have a greater emphasis on solid Earth sciences than the primary curriculum. According to experts, these topics are taught as part of the sub-disciplines that form part of the curriculum are the following:

- Geography: 71% of 15 countries;
- Geology: 57%, of 12 countries;
- Environmental sciences, Climate studies: 48% of 10 countries;
- Geoscience, Atmospheric sciences: 48% of 9 countries;
- pace and Planetary Sciences, Geography physical, Geography nature, 38% of 8 countries;
- Natural resources, Palaeontolo33% of 7 countries;
- Volcanology, Seismology, Hydrology: 29% of 6 countries;
- Soil science, Mineralogy, Marine science, Ocean life sciences, and Oceanography: 24% of 5 countries;
- Meteorology: 19% of 4 countries;

Graphic 10: Topics taught by the end of lower secondary education according to the curriculum (Expert´s opinion, non Latin-American countries, n=21)



Graphic 11: learning methods in Earth Sciences that are included in the curriculum (Expert´s opinion, non-Latin American countries, n=21)



- Geoinformatics, Disaster risk: 14% of 3 countries;
- Geophysics, Geospatial technology, Hydrogeology: 10% of 2 countries.
- Geomatics, Geographic information systems, Geodesy: 5% of 1 country.

Among these 21 countries, there is a range of different learning methods in Earth Sciences are mentioned to be included in the curriculum. As Graphic 11 shows, whilst a third of curricula require no specific learning methods -33%, 7 countries- more than half -57%, 12 countries- require experimentation, nearly a half -48%, 10 countries- use problem-based learning, 33% of 7 countries require fieldwork and 33% of 7 countries use modelling. So active learning in lower secondary Earth sciences is relatively widely-spread, despite the comments from one respondent, 'Theoretically all mentioned, in practice exposition and reading the textbook is more common'.

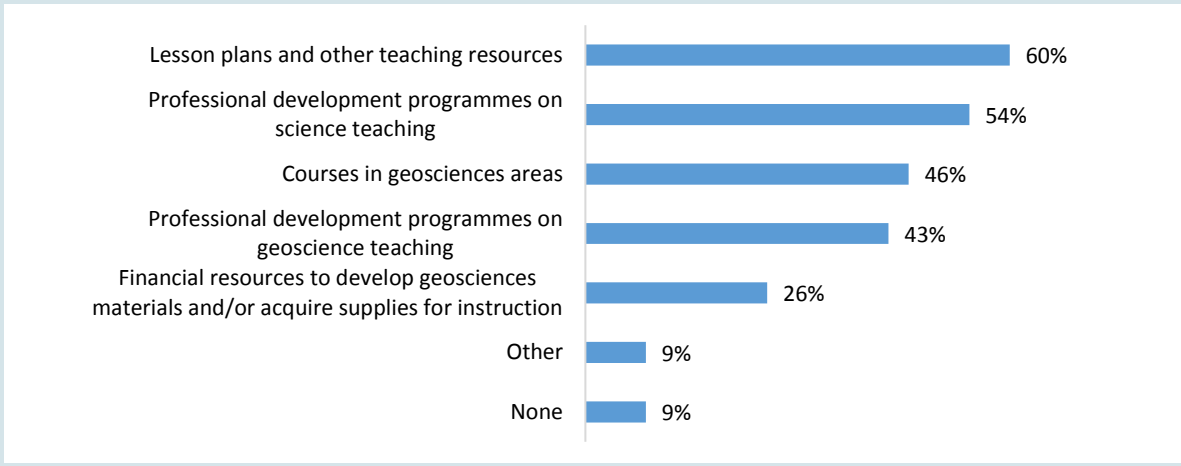
Of the 18 (64%) countries that have guidelines for **student´s assessment** in the Natural Sciences, only 5 (28%) countries that use standardized procedures in Natural Sciences reported that standardised assessments contain specific questions on Earth sciences. In 8 countries (44%) there are general questions about physical sciences in general including chemistry, physics and Earth Sciences and in 11% there are questions about Natural Sciences in general.

Finally, the results gave information about the preparation and support given to teachers for the teaching of Earth Science topics in lower secondary education. As Figure Graphic 12 shows, experts from the 35 surveyed countries indicate that in more than half of cases teachers have access to *lessons plan and other teaching resources* -60%, 21 countries- and *professional development programmes in science teaching* -54%, 19 countries-. In fewer cases they have access to *courses in geosciences areas* -46%, 16 countries- and *professional development programmes in geoscience teaching* -41%, 15 countries-. In 9 countries (26%), there are *financial resources to develop geosciences materials and/or acquire supplies for instruction*.

This pattern is like that of the support offered to primary teachers of Earth science (Graphic 7), with courses on geoscience education only being available to between 40 and 50% of teachers. Only around a quarter have access to financial resources to buy geoscience materials.

In 29 countries (83%), experts indicate that teaching materials supporting Earth science teaching at lower secondary level are available, but six countries do not have access to these materials. However, as at primary level, only in three quarters of countries are the resources of moderate or high quality. 5 countries are reported to have only poor-quality materials.

Graphic 12: Support given to lower secondary teachers for their teaching of Earth Science topics (Expert´s opinion, non- Latin American countries, n=35)



Upper secondary education: natural sciences curriculum, assessment & teaching

The questionnaire responses reported that 25 (71%) of the 35 surveyed non-Latin American countries have a compulsory national curriculum or program covering Natural Sciences in upper secondary education, whilst 5 (14%) have national standards or guides in this field 9% of countries having sub-national level standards or guides that cover Science. Only two countries do not have such guidance. 4 (11%) countries have a Natural Sciences curriculum or standards implemented at sub-national or regional level whilst only 3 (9%) have no national science curriculum covering science teaching at lower secondary level.

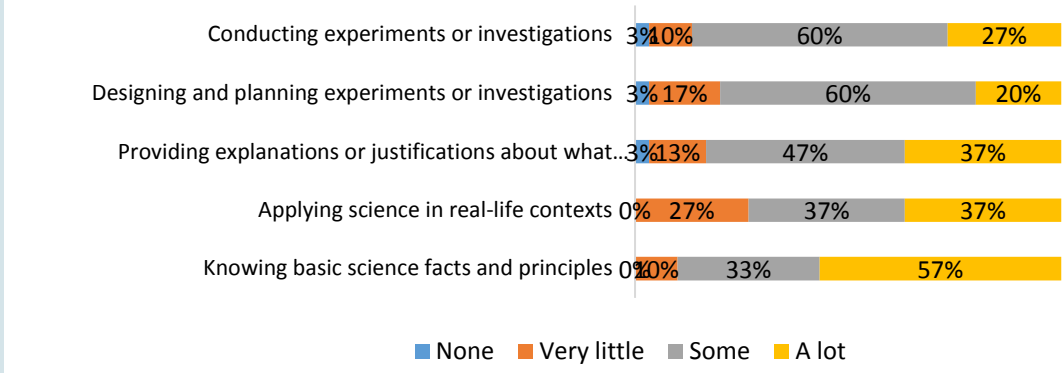
As stated by experts, in 24 (80%) of the 30 countries where there is a compulsory national curriculum or national standards covering Natural Sciences, there is a multiple branching system with specialist branches or streams of education open to students. Although there are multiple branches, in 15 (63%) of these countries all students can access tertiary education in Natural Sciences, whereas in 10 (42%) countries only students choosing scientific branches can access tertiary education in this field. In 15 (63%) countries, Natural Sciences subjects are compulsory for all students -choosing or not choosing Natural Sciences branches-.

Expert´s opinion on the main emphases of the curriculum by the 24 countries with multiple branching systems and 6 with no multiple branching systems are shown in Graphic 13. Graphic 13 shows that many countries give *a lot* -57%, 17 countries- or *some* -33%, 10 countries- emphasis to *knowing basic science facts and principles*. Most of them also give some -60%, 18 countries- or a lot -20%, 6 countries- of emphasis to *designing and planning experiments or investigations* and some -60%, 18 countries- or a lot -27%, 8 countries- to *conducting experiments or investigations*. 37% of 11 countries give some a lot of emphasis to *applying science in real-life contexts* and 47% of 14 countries- to *providing explanations or justifications about what is being studied*.

For students who do not choose Natural Sciences branches, the curriculum prescribes the percentage of total instructional time to be devoted to Natural Sciences only in 9 (38%) countries. For them, Natural Sciences subjects include: Physics and Chemistry (14 countries, 58%), Biology -12 countries, 50%-, Geography -11 countries, 46%-, Earth Sciences, Ecology and Environmental Sciences -6 countries, 25%-, Biochemistry -3 countries, 13%-.

For students who choose Natural Sciences branches, the main available branches are: Physical sciences -Chemistry, Earth sciences, and Physics- of 92%, 22 countries; Biological and related sciences -Biology and biochemistry- of 79%, 19 countries; and Environmental scienc-

Graphic 13: Main emphases of the Natural Science curricula for upper secondary education (Expert´s opinion, non Latin-American countries, n=30)



es -Ecology and environmental sciences- of 46%, 11 countries.

Regarding student's assessment, expert´s responses indicate that of the 30 countries that have a lower secondary school science national curriculum or standards, in 20 (67%) countries there are guidelines for the assessment in the Natural Sciences. In most of these countries, the most commonly used methods for student assessment are traditional written/oral examinations -93%, 28 countries- and students' performance in class -70%, 21 countries-, followed by project-based work -53%, 16 countries- and fieldwork -17%, 5 countries-. This shows a very similar pattern to that at primary level and lower secondary level, with examinations being the most commonly used technique, followed by student performance and project-based work, with fieldwork assessment having a low profile.

Of the 30 countries that have a compulsory national curriculum or national standards that cover Natural Sciences, 16 (53%) countries assess upper secondary Natural Sciences through compulsory national tests and a further 4 (13%) countries through non-compulsory national tests. International testing is used in around a third of countries -9 countries,30% compulsory and non-compulsory-, less than at lower secondary level. In most countries, student assessment data is mainly used for student evaluation -77%, 23 countries-, while secondary uses include teacher appraisal, accreditation-system and state-wide monitoring -53%, 13 countries-.

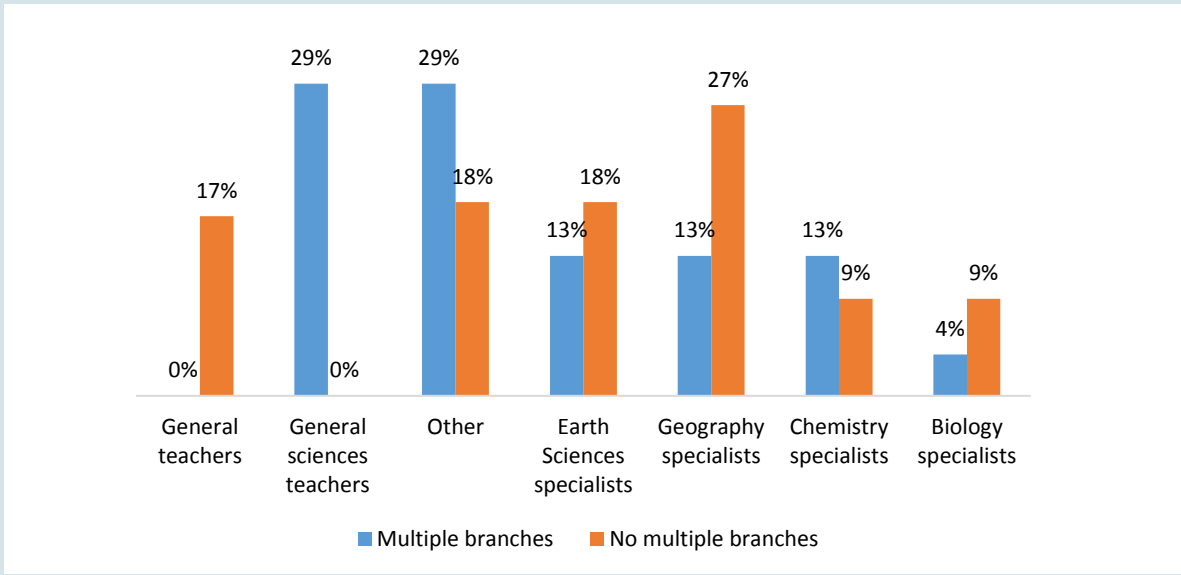
Experts from all 35 surveyed countries provided their opinion on the teaching of Natural Sciences at upper secondary level (Graphic 14). More than three quarters of countries -77%, 27 countries- have specialist Natural Sciences teachers at upper secondary level, a higher percentage than lower down the schools. 17 (49%) countries have also implemented methods to recruit or retain Natural Sciences teachers.

The pattern of preparation routes for Natural Sciences teachers at upper secondary level is like that at primary and lower secondary level: university degree (89%, 31 countries); teacher college program -7%, 13 countries-; completion of a probationary teaching period (3029 10 countries); passing a qualifying examination -23%, 8 countries-; and completion of a mentoring or induction program -14%, 5 countries-.

Experts also indicate that the support available to upper secondary Natural Sciences teachers is like that for lower secondary, except that education authorities provide more professional development at upper secondary level and there is slightly more emphasis on dealing with gender issues. They include:

- Specific continuing professional development (PD) activities in their official training programmes for in-service science teachers, 71%, of 25 countries;
- Public policies for the promotion of science education that include the improvement of science teacher education, 69%, of 24 countries;

Graphic 14: Profile of Earth Science teachers at upper secondary level (Expert's opinion, non Latin-American countries, n=35)



- National initiatives focusing on the initial teacher training of science teachers (54%, 19 countries);
- School partnerships, science centres and similar institutions that contribute to teachers' informal learning and provide advice of 51%, of 18 countries;
- Science centres that deliver formal continuing professional development (PD) activities for teachers, 29%, of 10 countries; and
- Dealing with gender -i.e. considering the different interests of boys and girls and avoiding gender stereotypes when interacting with students- is addressed in teacher education programmes, 26%, of 9 countries.

Earth Science at upper Secondary Level

According to the results, among the 6 countries with no multiple branching systems, in 4 countries the curriculum prescribes the percentage of total instructional time to be devoted to Earth Sciences for students. In these countries, the topics on Earth Sciences are mostly part of a Geography course and include the following sub-disciplines: Geomorphology, Climate Studies and Geography.

In the opinion of the respondents, in the cases of non-scientific branches, Earth Sciences content of the curriculum is followed not very closely in most schools, students are *very little,* or *some* encouraged/guided to investigate issues in Earth Sciences through the curriculum, and information about Earth Sciences-related careers intentionally included in instruction in a very little or some extent

The results also indicate that, among the 24 countries with multiple branching systems, in 10 (42%) countries the curriculum prescribes the percentage of total instructional time to be devoted to Earth Sciences for students who choose scientific branches. In the opinion of the respondents, Earth Science sub-disciplines that form a major part of the curriculum are the following:

- Earth Science: 54% of 13 countries;
- Climate Studies: 50% of 12 countries;
- Geography (natural and physical): 46% of 11 countries, each
- Environmental Science, Atmospheric Science, Natural Resources: 38% of 9 countries.
- Geology: 33% of 8 countries;
- Space and Planetary Science, Geoscience: 25% of 6 countries;

- Soil Science, Disaster Risks, Volcanology, Hydrology: 21% of 5 countries;
- Mineralogy, Marine Science, Oceanography: 17% of 4 countries;
- Seismology, Palaeontology, Meteorology, Geophysics, Geographic Information Systems (GUS): 13% of 3 countries;
- Ocean Life Sciences, Hydrogeology: 8% of 2 countries;
- Geospatial Technology, Geomatics, Geoinformatics: 4% of 1 country.

In the opinion of the respondents, in the case of scientific branches, Earth Sciences content of the curriculum is followed in most schools quite closely in 8 (33%) countries, not very closely in 9 (38%) countries and it is largely ignored in 4 (17%) countries. Only in three countries (13%) it is followed closely (Australia, Portugal, and United Kingdom).

In the case of Natural Sciences branches, students are generally encouraged/guided to investigate Earth sciences issues through the curriculum *very little*, 50%, 12 countries. In 8 (33%) students have *some* guidance, but in 3 (13%) the students receive *a lot* of guidance in the Earth sciences direction -Finland, Russia and South Korea-. Information intentionally included in the instruction about Earth Sciences careers is *very little* -50%, 12 countries-. In 25%, 6 countries, students of Natural Sciences branches receive "some" information and another quarter (25%) *none*. No students receive a lot of information. Change in font size here

Regarding student´s assessment in Earth Sciences, of the 20 of countries with standardized procedures in Natural Sciences, in 9 (30%) countries there are specific questions about Earth Sciences, in 7 (23%) here are general questions about physical sciences in general including chemistry, physics and Earth Sciences, while in 4 (13%) there are questions about Natural Sciences in general.

Regarding teaching in Earth Sciences, in countries with multiple branches systems, experts indicate that the approach to Earth Sciences teaching at upper secondary level can be summarized as generally taught by: General science teachers and Other teachers -9%, 7 countries each-; Earth science, Chemistry specialists or Geography specialists (13%, each); and Biology specialists (4%) (Graphic 14). In countries with no multiple branches system, values are: Earth Science specialists and other specialists (2 countries each); Geography, Chemistry and Biology, and General teachers -17%, 1 country each-,

In countries with multiple branches systems, teachers are prepared and supported with respect to teaching Earth Sciences topics through: "lesson plans and other teaching resources" (58%, 14 countries each); *professional development programmers on science teaching*, *professional development programmers on geoscience teaching* and *courses in geosciences areas* -54%, 13 countries-; *financial resources to develop geosciences materials and/or acquire supplies for instruction* -29%, 7 countries-; other mechanisms -17%, 4 countries- and none -8%, 2 countries-. This shows some differences for countries with no multiple branches systems, where "*professional development programmers on science teaching* and *courses in geosciences areas* have more importance.

The pattern in Graphic 15 is like that at lower secondary level (Graphic 12) except that the support given by lesson plans and teaching resources is somewhat reduced. The Experts stated that less than 50% of teachers of Earth science have access to specialist geoscience teaching courses, whilst the availability of financial resources remains low, at just over 20%. Three countries (9%) have no support at all.

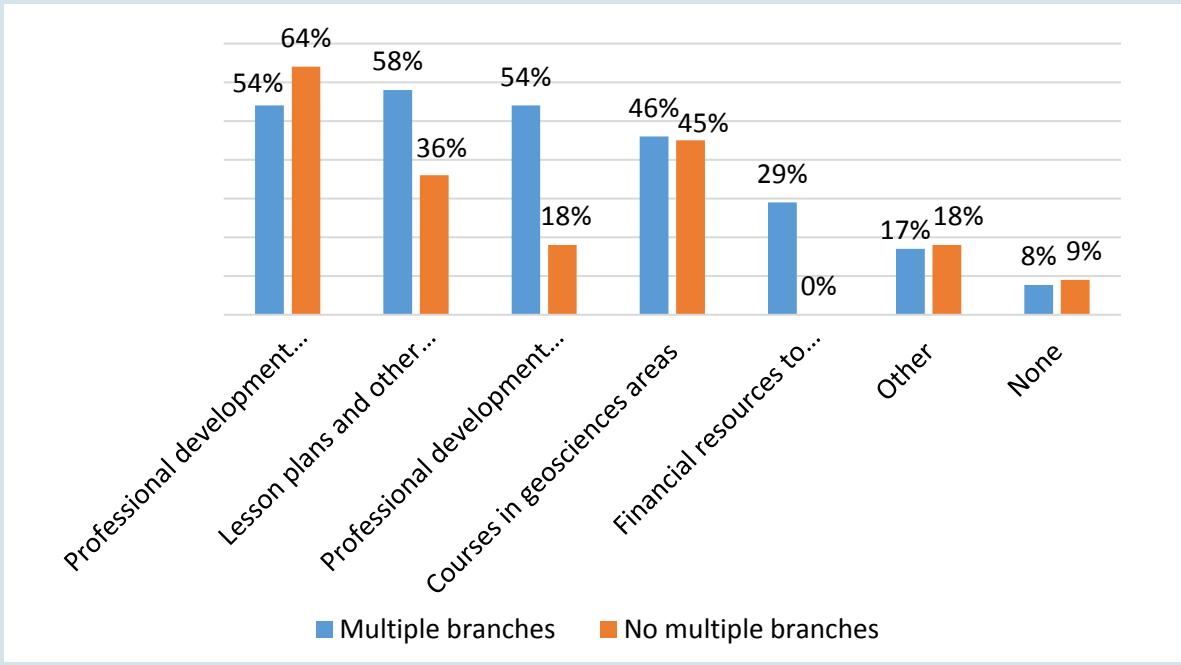
Results show that Earth Science teaching materials are available in 28 (80%) of the 35 countries, but 7 countries (19%) have no such resources. In most countries where there is a multiple branching system, these teaching materials is moderate (67%, 16 countries) or high (17%, 4 countries), with only 2 countries reporting poor quality.). This is an improvement on the quality of resources available at lower secondary level.

Extracurricular activities & innovations

As stated by experts, from the 35 surveyed countries, only just over a third of countries -37%, 13 countries- have guidelines or recommendations in place encouraging schools to provide extra-curricular or extra-program activities in Natural Sciences. In these countries, among the main organizations providing students with activities that go beyond school are:

- Museums and interactive science centres, 85%, of 11 countries;

Graphic 15: Support given to upper secondary teachers for their teaching of Earth Sciences (Expert´s opinion, non Latin American countries, n=35)



- National parks, parks with Earth Science focus, 70%, of 9 countries);
- Groups aimed at children, 70%, of 9 countries;
- Public understanding organizations focusing on Earth Sciences and UNESCO Global Geoparks Networks and networks protecting sites of geological heritage 62%, of 8 countries;
- Earth Science content in local public understanding of science events, 62%, of 8 countries;
- Private sector organizations, 46%, of 6 countries; and
- Local "rock hound" groups. 23%, of 3 countries.

The results indicate that in 17 of the surveyed countries there are regular national events of a range of different types held for the promotion of Earth sciences. In their free responses, three countries (9%) commented on the importance of Earth science week and two other countries (6%) on Earth day. Regarding their focus, in general these events are:

- Open to public, although pupils and students are the main target and specific activities are arranged for them: 40% -14 countries;
- Science promotion events are targeted specifically at schools: 31% -11 countries-;
- Focused solely on the school population: 26% -9 countries-;
- Most contests and competitions are aimed at secondary level students: 20% -7 countries-.

Noticeable, whilst the events are open to the public (with students being the focus) in more than a third of countries (40%), events focussed only on schools are reported by nearly a third of countries as well (26%).

Of the 35 countries responding to the survey, experts from more than half (54%) reported the presence of research groups in their counties focussed on Earth science education. In addition, 21 countries indicated they participate in national Earth science Olympiads and 5 countries reported on the importance of these events in their free responses (14%).

Nearly two thirds of countries -66%, of 23- reported innovations in the teaching of Earth science in the past ten years. In their free responses, 7 of these countries reporting innovations indicated that this was in response to curriculum change, whilst three countries reported

the development of new curriculum materials for Earth science teaching.

Results show that in almost two thirds of the country's -63%, of 20- Earth science educators have promoted or influenced social change (for example, petitions or actions on issues of: protection/ remediation of pollution; conservation/ sustainable exploitation of natural resources; protection of the landscape/ areas of geological interest; among others). In free responses, four countries noted the development of UNESCO Global Geoparks and UNESCO World Heritage Sites whilst three countries noted the importance of promoting geosites.

Final remarks

Science education

Regarding policies in science education, results indicate that whilst most countries (86%) had policies to strengthen science education, only five countries had not. These policies had a wide range of drivers, goals and approaches, but the most important approach across the world -83% of countries, n=25- has been curriculum reform.

About science education in the natural sciences, the reporting from across the world at primary, lower secondary and upper secondary level showed a strong focus on the knowledge of basic science facts and principles but increasing requirement to provide explanations in older pupils. The level of investigation and experimentation was largely similar at all levels of the curriculum.

According to the experts' opinion, most countries had guidelines for assessment in the natural sciences, based mainly on traditional written/oral exams -e.g. in more than 90% of countries at upper secondary level (n=28)-.

The number of specialist secondary science teachers in the natural science increased up the school -34% at primary, 63% at lower secondary, 77% at upper secondary-. 40% of countries (n=35) have implemented policies to recruit or retain teachers at lower secondary level, and this increased to 49% at upper secondary level. At all levels, most teachers are trained though university degree programmers and teacher college programmers, whilst around a third must complete probationary periods in school.

At all levels in most countries there are public policies focused on improving science teacher education with professional development provided by education authorities and national initiatives for initial teacher training. In less than a third of countries at all levels, is dealing with gender issues included in these programmers.

Earth science education

In this survey, experts form all 35 countries indicated that they had a curriculum covering natural sciences at primary and lower secondary levels whilst 33 of the 35 countries have a natural science curriculum at upper secondary level; only two do not.

At primary level only, experts from 25 countries responded to the questions about Earth science, which may indicate that the ten countries in which experts did not respond, do not teach Earth science at primary level. Meanwhile, of the 25 countries which did respond, five countries indicated that they do not include Earth science in the primary curriculum; data is therefore only available for 20 countries. This may indicate that – according to the experts' opinion - only 20 of the 35 countries surveyed teach primary Earth science (57%). This is a much lower figure than indicated by the data collected in the 2013 survey, where 26 of the 31 countries that responded had an Earth science curriculum for 7-11-year olds (84%).

The data at lower secondary level is similar. As the results show, 28 of the 35 countries responded to the Earth science questions and these responses included seven countries that do not have Earth science in their lower secondary curriculum, so that only 21 of the countries surveyed indicated that they do teach lower secondary Earth science (60%). Again, this is a much lower figure than shown by the 2013 survey, where 84% of countries had a lower secondary Earth science curriculum.

At upper secondary level, the Earth science content of the curriculum is more difficult to establish from the current survey, since only experts from 30 countries responded to questions about the structure of the curriculum indicating that some countries have a multiple branching system (80%) and some do not (20% - 6 countries). They stated that in some of the countries which do have a multiple branching system, natural sciences are compulsory (63%, n=24) and in others they are not. In their opinion, for both students who opt to study natural sciences and those that do not, there is an Earth science component to the curriculum in many

Table 16. The views or respondents on how closely the national curriculum guidelines in Earth science are followed.

The opinions of respondents		Primary (n=20)	Lower secondary (n=21)
The Earth science curriculum guidance is:	followed very closely	10%	19%
	followed quite closely	45%	48%
	not very closely followed	40%	24%
	largely ignored	5% (1 country)	10% (2 countries)

countries, however in only 10 countries is the amount of Earth science to be taught prescribed. The 2013 survey indicated that 74% of countries had compulsory Earth science at upper secondary level.

In addition, in the current survey, respondents were asked if, in their opinion, the curriculum guidance in Earth science was closely followed or not (Table 16). The Table 16 data shows that, even in those countries which do have guidelines in Earth science teaching in place, these are not closely followed or are ignored in around a third of countries.

Thus, the current survey paints a significantly bleaker picture than that found by the 2013 survey, which concluded, 'there is fairly good coverage of Earth science in the school curriculum globally – particularly for 7 – 16-year old. A more accurate statement for the current survey might be: that the Earth science coverage of curricula across the world is variable, with significant numbers of countries having no reported Earth science curriculum; for those countries that do have Earth science curriculum guidance, the guidance is not closely followed in a significant number of countries.

Table 17. The components forming more than 30% of the curriculum at each level.

Primary (n=20)	Lower secondary (n=21)	Upper secondary (n=24)
Water on Earth – 90%	Earth science – 71%	Earth science – 54%
Solar system – 85%	Geology – 57%	Climate studies – 50%
Landscape – 85%	Environmental sciences – 48%	Geography (physical) – 46%
Weather – 80%	Atmospheric Sciences – 43%	24%
	Geography (nature) – 46%	24%
Day/night and Earth's rotation – 75%	Geoscience – 43%	Environmental sciences – 38%
Fossils – 60%	Geography (nature) – 38%	Atmospheric sciences – 38%
Climate change -55%	Geography (physical) – 38%	Natural resources – 38%
Environmental risks – 45%	Space and Planetary Sciences – 38%	Geology – 33%
Soil erosion – 45%	Palaeontology – 33%	
Geological resources and heritage – 40%	Natural resources – 33%	
All available options available in the questionnaire were indicated at more than 30%	*18 of the options available in the questionnaire were indicated at less than 30%*	*20 of the options available in the questionnaire were indicated at less than 30%*

Table 18. The percentages of countries with specific Earth-science-related questions in their standardized assessments.

The Earth science curriculum guidance is:	Primary (n=16)	Lower secondary (n=35)	Upper secondary (n=30)
	31%	28%	30%

As experts also indicated, for countries that do teach Earth science, the scope of the Earth science taught changes up the curriculum. The Earth science subject areas comprising more than 30% of the curriculum at each level are shown in Table 17. The data in Table 17 shows that the atmosphere forms a key component of study at all levels and space and planetary sciences also have a high profile. Earth science, geology and geoscience as subject areas, form important components of the curriculum above primary level, as does geography.

Table 18 shows the percentages of countries with Earth science questions in their assessments. As Table 18 shows, the experts indicated that most countries do not have Earth-science specific questions in their assessment procedures, and this situation is worse in secondary schools.

The support available to teachers of Earth science at different teaching levels is summarized in Table 19. As Table 19 shows, the experts understand that specific geoscience support is only available in less than half the countries surveyed, whilst financial support for Earth science teaching is only available in around a quarter of the countries surveyed.

Table 20 summarizes the availability and quality of Earth science teaching material available in the 35 countries which contributed to the survey.Table 20 shows that experts believe that in approaching a fifth of countries, no teaching materials are available for the teaching of Earth sciences, these, presumably are the countries with little or no Earth science in their curriculum. However, in most countries the quality of materials is only moderate or poor, with high quality materials being used only a few countries. It seems that the quality of textbooks has improved since the 2013 survey, where the situation was summarized as: 'more than half the textbooks for elementary students and more than a third of textbooks for high school students are of poor quality or are not available' (p.26), nevertheless it is worrying that the available of high-quality Earth science teaching material is still so limited across the world.

Table 19. Support provided to teachers of Earth science.

Support provided	Primary (n=35)	Lower secondary (n=35)	Upper secondary (n=35)
Professional development programmers on science teaching	49%	54%	57%
Lesson plans and other teaching resources	46%	60%	51%
Courses in geoscience areas	40%	46%	46%
Professional development programmers on geoscience teaching	37%	43%	43%
Financial resources to develop geoscience materials and/or acquire supplies for instruction	26%	26%	20%
None	11%	9%	9%

Table 20. Availability and quality of Earth science teaching material.

Earth science teaching material		Primary	Lower secondary	Upper secondary
Percentage of countries where Earth science teaching material is available		49%	54%	57%
The quality of Earth science teaching material is:	high	9%	11%	17%
	moderate	63%	60%	63%
	poor	14%	17%	9%
	not applicable	14%	11%	11%

Earth science education – a conclusion

The main finding of the Earth-science-specific sections of this survey, in comparison with the 2013 international survey is that the Earth science teaching situation across the world is significantly poorer than in 2013. This could be for the following reasons.

- The situation has become poorer.
- The style of the questionnaire questions is different between the different surveys, prompting different responses.
- The questionnaire medium is different (paper questionnaire in 2013, electronic in this survey).
- The countries included in the survey are different.

Of the 34 countries included in the 2013 survey, the countries not included in the current survey were: the Latin American countries Argentina, Brazil and Uruguay, and the other countries, Bangladesh, Belgium, Czech Republic, Estonia, Romania, Saudi Arabia, Scotland, and Trinidad and Tobago -11 countries in all-. Meanwhile, the 14 countries which took part in the current survey, which were not represented in the 2013 survey were: Bulgaria, China, Denmark, Egypt, Greece, Hong Kong, Iran, Kyrgyzstan, Mauritius, Mongolia, Namibia, Pakistan, Turkey, and Zambia.

Whichever of these reasons has had most impact, the fact remains that the current situation does appear to be poorer than previously, and can be summarised as above, namely: 'that the Earth science coverage of curricula across the world is variable, with significant numbers of countries having no reported Earth science curriculum; for those countries that do have Earth science curriculum guidance, the guidance is not closely followed in a significant number of countries.'

Other significant findings relating to Earth science in the current survey are as follows.

- In most countries where Earth science is studied, the primary curriculum tends to focus on the atmosphere and Earth in space; this continues up the curriculum, with an increasing emphasis on solid Earth sciences.
- Less than half the countries surveyed have Earth science-related questions in their assessments.
- Specific support for geoscience teaching is available in less than half the countries
- Financial support for the teaching of Earth science is only provided in around a quarter of the countries.
- In most countries the quality of teaching material available for the teaching of Earth science is only of moderate quality and is poor in a significant minority of countries, however, this did show a small improvement on the textbook-quality data from the 2013 survey.

In conclusion, therefore, the state of Earth science education across the world shows scope for major improvement in several areas and regions. It is to be hoped that, by raising awareness of these issues through this survey, more emphasis on, and support for, Earth science education across the world can be provided by all agencies concerned in the future.

Geoscience education in Latin America and the Caribbean

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Denise GORFINKIEL
Program Officer,
International Program of Geo-Sciences and Geoparks,
Regional Science Office for Latin America and the Caribbean,
UNESCO Montevideo

Background

Based in the Regional Office of Sciences of UNESCO for Latin America and the Caribbean, the International Geosciences and Geoparks Program is particularly interested in supporting the development of Geoscience to help countries benefit from and contribute to sustainable development. For this reason, as mentioned in the introduction, the goal of the project "Building a community vision for Geosciences education in Latin America and the Caribbean" was to make a first diagnosis of regional capacities, needs and opportunities in Earth Science education. It is envisaged that this information could help develop a community vision for geoscience education and to plot the way ahead for national policies and international cooperation in the field.

It is important to notice that this survey has a built-in bias, in the sense that it is an *opinion survey* and not an in-depth study of the existing national curricula. Most respondents are academic experts in the field of Natural Sciences or Earth Sciences education, which has a strong interest on Geosciences teaching but who in some cases can be unaware of specific details of some general political or technical aspects of their national educational scene. In this sense, far for being conclusive, this study must be taken as a first general attempt to describe the current state of the art of Geoscience education.

The survey results we obtained in Latin America and the Caribbean are presented below. To facilitate the comparative analysis of the great quantity of numbers and indicators, the text follows an identical format to that proposed by my colleague, Chris King, in the previous article. I hope you find interesting our findings.

Introduction

In Latin America and the Caribbean, experts from 16 countries responded to the *Experts survey on geoscience education: approaching Earth Sciences in primary and secondary education* (see Table 21). The profile of those responding to the survey at the regional level indicated that 62% of the contributors held Doctorates, and an additional 31% held master's Degrees; 50% were male and 50% female. Sixty two percent of those responding were from universities, 12.5% from research centres, 12.5% from National Ministries of Education, and 12.5% from National Agency of Education. One is member of the International Geoscience Education Organisation (IGEO). These data illustrate the scope of expertise that was applied to completion of the survey in the region.

Table 21. The list of countries covered by the survey among Latin American countries.

Argentina	Colombia	El Salvador	Nicaragua
Bolivia	Costa Rica	Guatemala	Perú
Brasil	Cuba	Guyana	Uruguay
Chile	Ecuador	México	Venezuela

General policies on Science Education

According to experts from the 16 countries surveyed in Latina America and the Caribbean, most of them (93%) reported that there is a range of national policies to raise the profile of natural science in education. In 80% of the countries, these national policies are not framed within supra-national strategies, though some of the experts indicate there is some coordinated approach at national and sub-national level (47%).

Two thirds 60%, of 9 countries with national policies noted they have measurable objectives for their implementation and follow up, but only in 47% (7 countries) of these countries there is monitoring of the development of past and current policies. Performance of policies is evaluated with independence of the Education Ministries or National Education Agencies in 40% of 6 countries of these cases, with the publication of results and evaluation report in 73% of them of 11 countries.

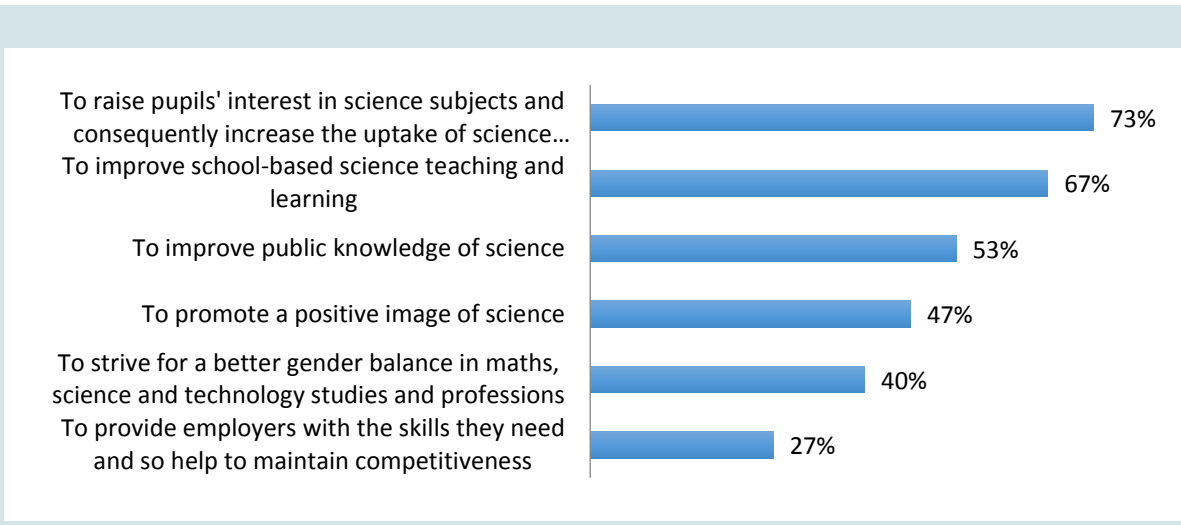
In general, the principal types of national policies implemented in Latin American and Caribbean countries are:

- Individual programmed documents and projects -such as school partnerships and science centers- with a science guidance purpose, 62%, of 10 countries;
- General policies encompassing all stages of science education and training, 50%, of 8 countries;
- Policies or programmed documents focusing on stages of education and or specific areas of learning, 37%, of 6 countries;
- Broad strategic framework document to raise the profile of science in education and wider society, 31%, of 5 countries;
- Other type of policies, 37%, of 6 countries); and
- None, 6%, of 1 country.

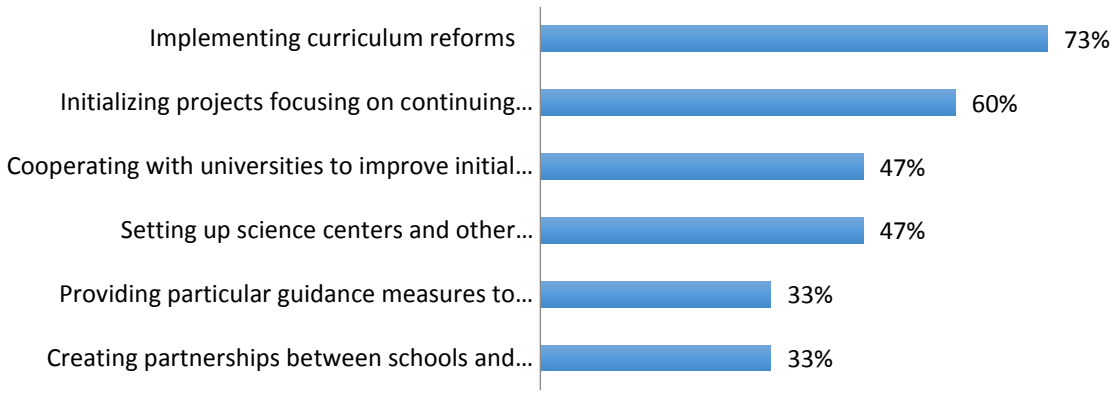
The reasons given for these policy developments are mainly the rising demand for qualified researchers and technicians -60%, 9 countries- and the unsatisfactory results in international educational performance surveys -53%, 8 countries-. Other reasons include the concern that there may be a decline in innovation and, consequently, economic competitiveness -47%, 7 countries- and the declining interest in science studies and related professions, 40%, of 6 countries.

Regarding the educational goals of these national policies (see Graphic 22), experts note that the most important ones are: to raise pupils' interest in science subjects and consequently increase the uptake of science studies at upper secondary and tertiary education levels -73%, 11 countries- followed by improving school-based science teaching and learning -67%, 10 countries-. Other goals mentioned are: to improve public knowledge of science -53%, 8 countries-; to promote a positive image of science 47%, 7 countries, to strive for a better

Graphic 22: Main broad educational goals of national policies to raise the profile of Science in education (Expert´s opinion, Latin American and Caribbean countries, n= 15)



Graphic 23: Main approaches to implement national policies to raise the profile of Science education (Expert´s opinion, Latin American and Caribbean countries, n= 15)



gender balance in math, science and technology studies and professions -40%, 6 countries, and to provide employers with the skills they need and so help to maintain competitiveness -27%, 4 countries.

Graphic 23 shows the approaches that governments are attempting to implement to achieve these goals. The most important approach adopted by most of the governments, according to the experts, is to implement curriculum reforms -73%, 15 countries-. Nonetheless, other strategies implemented are initializing projects focusing on continuing professional development for teachers -60%, 9 countries-, cooperating with universities to improve initial teacher education, and setting up science center's and other organizations -47% each, 7 countries-. Also, governments provide guidance measures to encourage more young people to choose scientific careers and create partnerships between schools and private sector, scientists and research center's (33% each, 5 countries).

Primary Education: Natural Sciences curriculum, assessment, and teaching

The questionnaire responses reported that 13 (81%) of the surveyed countries have a national curriculum covering Natural Sciences in primary education, whereas a further 2 (13%) countries have national standards or guidelines. Only one country mentioned having curricula or standards implemented at sub-national level.

In most of the cases (15 countries), national curriculums or standards introduce Natural Sciences from 1st grade -6-7-year olds, (67%). In 3 countries (20%), these are introduced from 3rd grade -8-9-year olds-. In 1 of countries (7%) of the cases, Natural Sciences are included from 2nd grade (7-8-year olds) and from 5th grade (10-11 years old). National Ministries of Education provide curriculum or standards in 93% of the cases (14 countries).

The national curricula prescribe mostly materials such as textbooks or assessment methods -93%, 14 countries- as well as goals and objectives -87%, 13 countries- and instructional processes or methods -67%, 10 countries-. More than half of the primary science curricula prescribe the amount of instructional time to be devoted to Natural Sciences -73%, 5 countries-. In the responses from some countries, primary science teaching time is given as a percentage, and in some as several hours, whilst in others, it is different at different grades; however, the mean for those countries reporting percentage of curriculum time devoted to primary science education is around 17%, ranging from 10% to 25% of15 countries.

Graphic 24 highlights expert´s opinion on the most important emphases of Natural Sciences curricula in primary science of the 15 countries that have national curriculums or standards. The figure shows that 40% of 6 countries gives a *lot* of emphases to *applying sciences in real life context*. 67% of 10 countries puts *some* empha-

ses to *conducting experiments or investigations* and 60% of 9 countries to *designing and planning experiments or investigations* and on *knowing basic science facts and principles*. Noticeably, the emphasis that emerge as the least applied in some of the countries are *providing explanations or justifications about what is being studied* and *applying sciences in real life context*, 7%, of 1 country.

Regarding student´s assessment, experts responses indicate that in 93% of 15 countries, that have national curriculums or standards, the curriculum provides guidance for assessment in the Natural Sciences field. They indicate that in most of these countries, 86% of 12, primary science assessment is done through *traditional written and oral examinations*; but *student´s class performance*, 64% of 9 countries and *project-based work*, 57% of 8 countries, are also important. *Fieldwork* is mentioned in two cases -14%, of 2 countries.

Most of these countries addressed student knowledge and skills in Natural Sciences through standardized procedures at the national -8 cases- or international -5 cases- levels, being compulsory in5 countries for the national level and 4 countries for the international one. In 57% of 8 countries, student assessment data is mainly used for *student evaluation* and for *state-wide monitoring*; in 36% -5 countries- of the cases for *teacher appraisal*; and in 7% -1 country- for accreditation systems. However, in 29% -4 countries- it is not applicable since there are no standardized procedures.

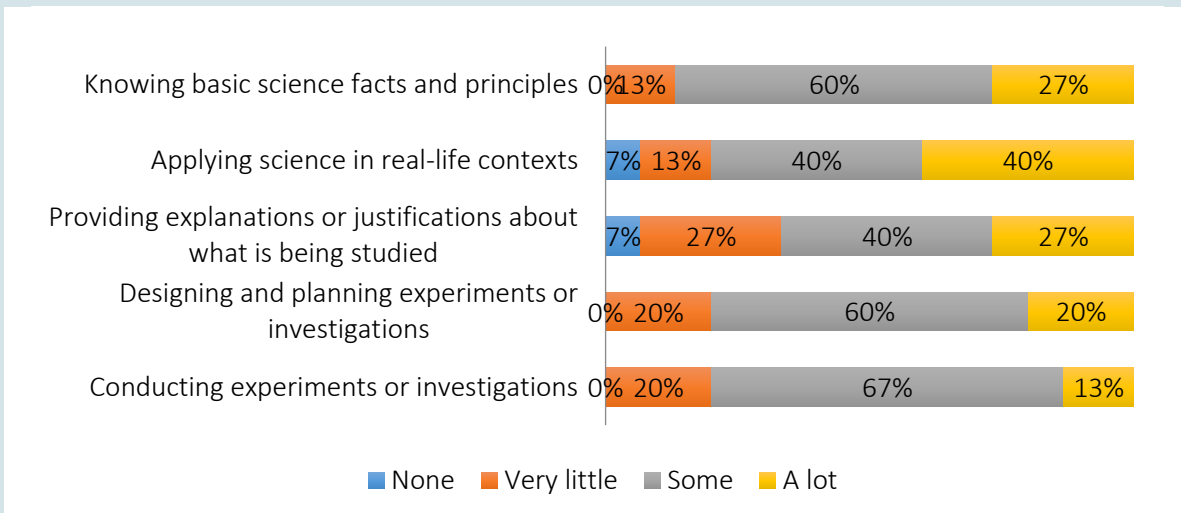
All 16 surveyed countries provided data on the teaching of Natural Sciences at primary level. According to the experts, 75% -12 countries- of the countries do not have teachers who teach only Natural Sciences during primary education. As Graphic 25 shows, in most cases, the approach to Natural Sciences teaching is generally taught by general science teachers -62%, 10 countries- followed by general teachers -48%, 7 countries-. In 19% -3 countries- of the cases, Biology specialists teach Natural Science at the primary level, while in 6% -1 countries- of the cases Chemistry specialists teach it.

In general, primary teachers are trained through university degree -63%, 10 countries- and teacher college programmes -31%, 5 countries-; 13% -2 countries- must pass a qualifying exam, whilst 6% complete a probationary teaching period or a mentoring or induction programme and in other 44% -7 countries- are trained through other programmes.

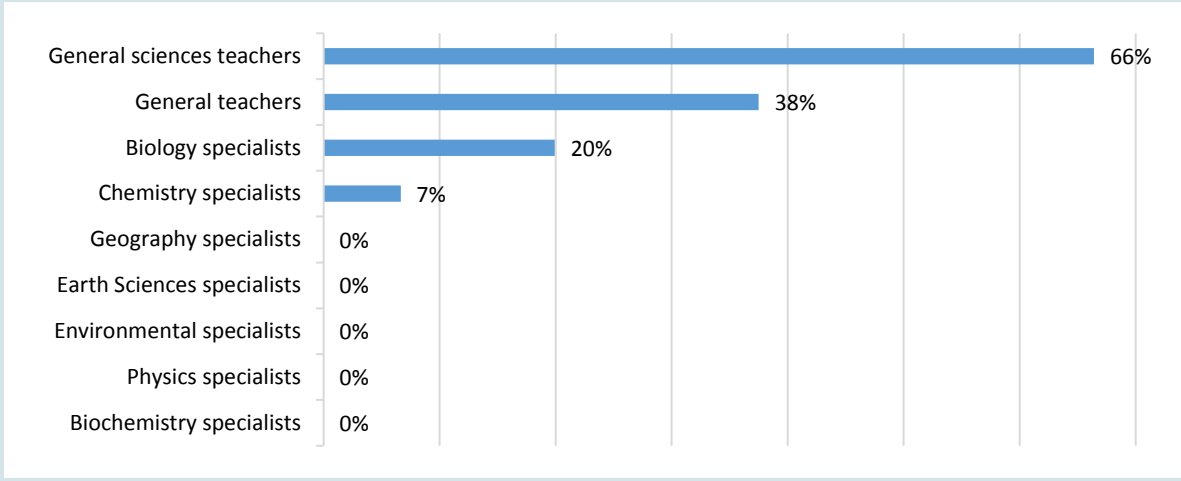
Different types of support available to teachers of primary natural sciences across the 16 countries surveyed includes mainly:

- Specific continuing Professional Development (PD) activities provided by education authorities in their official training programmes for in-service science teachers -56%, 9 of countries-;
- Public policies for the promotion of science education that include the improvement of science teacher education -50%, 8 of countries-;

Graphic 24: Main emphases of Natural Science curricula for primary education (Expert´s opinion, Latin American and Caribbean countries, n=15)



Graphic 25: Profile of Natural Science teachers at primary level (Expert´s opinion, Latin American and Caribbean countries, n=16)



- Teacher education programmes dealing with gender (i.e. considering the different interests of boys and girls, and avoiding gender stereotypes when interacting with students) is addressed in teacher education programmes -50%, 8 countries-;
- School partnerships, science centres and similar institutions that contribute to teachers' informal learning and provide advice -44%, 7 countries-;
- National initiatives focusing on the initial teacher training of science teachers -25%, 4 countries-;
- Science centre's that deliver formal continuing professional development (PD) activities for teachers -19%, 3 countries-.

Earth Science at Primary Level

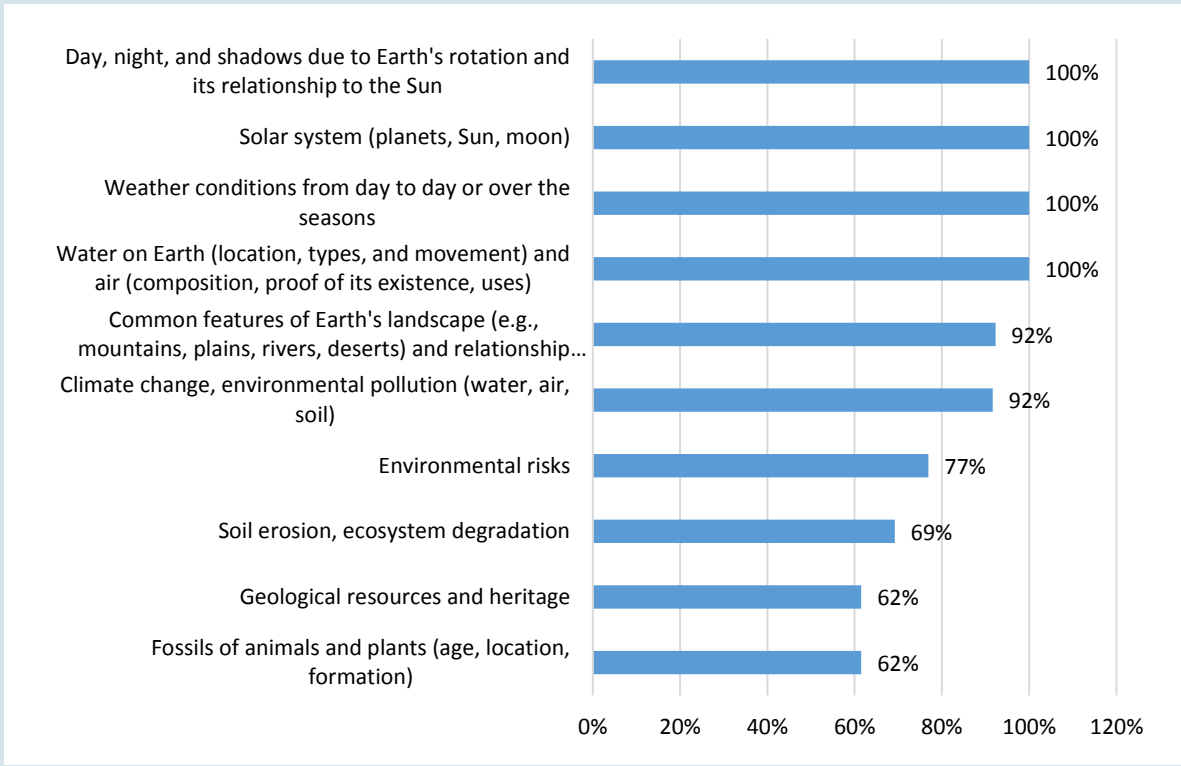
From the 15 countries that have national curriculums or standards, 13 (87%) have Earth Science in their primary curriculum whilst two countries do not. According to the experts responding the survey, 62% of 8 countries of the cases follow the primary Earth science curriculum quite closely while it is not closely followed by 38% of 5 countries of the cases.

The topics covered by primary Earth sciences indicated by 13 responses are shown in Graphic 26. Graphic 26 indicates that water on earth and air, the solar system, day and night, and shadows due *to earth's rotation*, and *weather conditions* (100%, or 13 countries each) play key roles in the primary Earth science curriculum, as does the study of *Earth´s landscape and their human use* as well as *climate change and environmental pollution* -92%, 12 countries-. *Environmental risks* -77%, 10 countries-, *soil erosion and ecosystem degradation* -70%, 9 countries- are also covered. *Geological resources and heritage* together with *fossils of animals and plants* are less studied (62%, 8 countries) though still in more than half of the surveyed countries.

In those countries that have national standardised procedures for student ´s assessment in the primary natural sciences, 2 countries (14%) indicated that specific questions about Earth sciences are included. In only one county, there are general questions about Physical Sciences in general, including Chemistry, Physics and Earth Sciences (7%). In 5 countries, (36%) there are questions about Natural Sciences in general. However, 6 countries (43%) responded that there are no standardized procedures.

The questionnaire also provides evidence regarding the preparation and support given to teachers for the education of Earth Science topics in primary education. As Graphic 27 indicates, from the 16 countries that *lesson plans and other teaching resources* is the most common supports takes 69% -11 of countries-. Whilst, only 19% -3 countries- of the teachers have access to *courses in geoscience areas*. None has access to *financial resources available for the purchase of geoscience teaching materials*

Graphic 26: Topics taught by the end of primary education according to the curriculum (Expert´s opinion, Latin American and Caribbean countries, n=13)



and only 6% -1 countries- have *professional development programmes in geoscience teaching*. Still, more than half (69%) has access to *lesson plans and other resources available to them*; whilst 5 countries (31%) indicate they have *professional development programmes on science teaching*.

Regarding **teaching materials** available to support Earth Sciences teaching, three quarters of the country's -75%, 12 - said that teaching materials are available for the teaching of Earth sciences at primary level. The general assessment of the reviewers -69%, 11 countries- is that the quality of the teaching materials provided, where available, is only moderate, but for one country, Earth Science teaching material are of high quality.

Lower Secondary Education: natural sciences curriculum, assessment and teaching

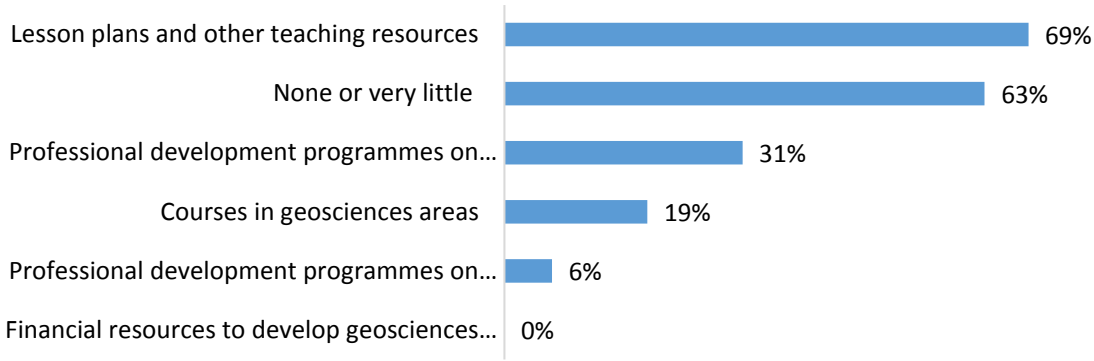
Experts' responses from the 14 indicated that 88% of the 16 surveyed countries have a compulsory National Curriculum or Programme covering natural sciences, with a further 13% of the countries having national standards or guides that cover Science. None of the countries surveyed had curricula or standards implemented at sub-national level.

Most of these countries implement their lower secondary science curriculum or standards from 1st grade -7 - 8-year olds-, -81%, 13 countries-, some from 4th grade -13 - 14-year olds-, 6%, 1 country- and some from fifth grade, 15 - 16-year olds, 13%, 2 countries-. National Ministries of Education provide 94% of 15 countries of the National Science curricula or standards and 6% are provided by National Agencies.

Among the 16 countries that have a lower secondary school science national curriculum or standards covering Natural Sciences, 15 countries (94%) sets goals and objectives, 13 countries (81%) covers instructional processes and methods and more than a third -12 countries, 75%- specify instructional materials and/or assessment methods.

In 14 countries (88%) of the countries surveyed, the curriculum documents stipulate the percentage of time

Graphic 27: Support given to primary teachers for their teaching in Earth Science (Expert´s opinion, Latin American and Caribbean countries, n=16)

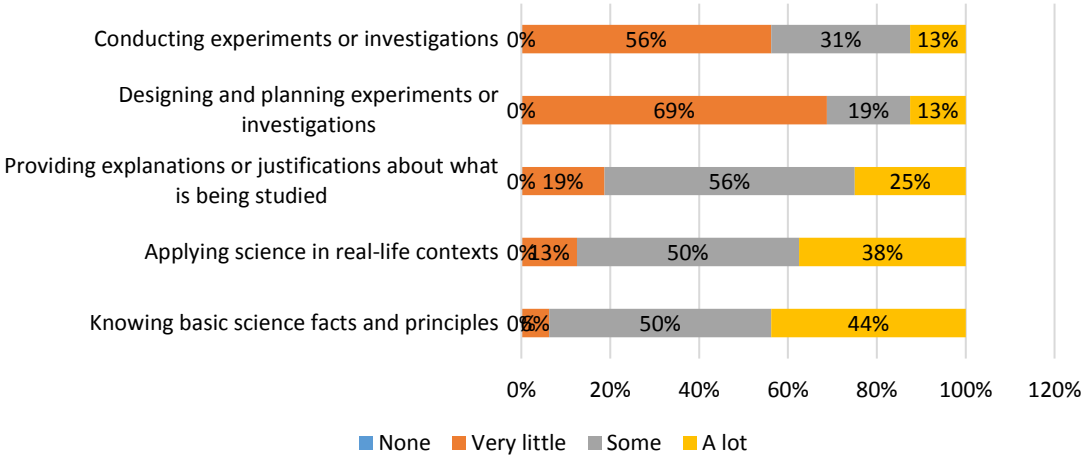


to be devoted to natural sciences. Where an amount of time is specified, this may be in numbers of hours, nevertheless, where percentages were given in the responses the 14 countries, the mean amount of time was 23%, ranging from 10% – 45%.

The main emphases placed on the curriculum by the experts representing the 16 countries that responded the questionnaire are shown in Graphic 28. Graphic 28 shows that 44% -7 countries- of the countries give a *lot* or *some* -50%, 8 countries- emphasis to *knowing basic science facts and principles*. Half of the country's -50%, of 8 - give *some* or a "lot" (38%) of emphasis to *applying science in real-life contexts*. 56% of 9 countries, gives *some* emphases to *providing explanations or justifications about what is being studied* while 44% of 7 countries give a *lot* of emphases.

Graphic 28 shows that, whilst more emphasis on *knowing scientific facts and principles* and *applying science in real-life context* continues from primary science (see Graphic 24), there is less emphasis on *conducting exper-*

Graphic 28. Emphases of the lower secondary science curricula (Expert´s opinion, Latin American and Caribbean countries, n=16)



iments or investigations, *designing and planning investigations* and *providing explanations or justifications about what is being studied*.

Regarding techniques for student's assessment, things look quite similar as in primary level. In the 94% of 15 countries of the countries that have lower secondary school science national curriculum or standards, there are guidelines for the assessment of the natural sciences. In most of these countries, most commonly used methods for student assessment are traditional written or oral examinations -87%, 13 countries-, and students' performance in class, 67%, of 10 countries, followed by project-based work, 47%of 7 countries, and fieldwork -13%, 2 countries-. Two countries mentioned that all of them are important.

As at primary level, the strong emphasis is on traditional written or oral examination, and class performance. Nevertheless, project-based work has a high profile though a little less important than at primary level. As at primary level, fieldwork-based assessment is less usual.

Regarding student´s assessment, among the countries surveyed, national tests are compulsory in 7 countries (50%) of the cases, whilst international tests when used -compulsory or not- are applied in 6 (60%) of the countries. In 10 (67%) of the countries, student assessment data is mainly used for student evaluation, in 9 (60%) of the countries is for state-wide monitoring, in 6 (40%) of the countries for teacher appraisal, and 3 (20%) of the countries for accreditation system.

All 16 countries provided data on the **teaching of natural sciences** at lower secondary level. 14 (88%) of the countries have teachers who teach only Natural Sciences during lower secondary education but only 2 (13%) of the countries have implemented specific actions to recruit or retain lower secondary science teachers. The profile of teachers teaching Earth science at lower secondary level shows that most secondary science teachers in the countries surveyed are general science teachers, 9 countries of 56%, including a range of other specialists, such as biology, geography, chemistry and physics 31%, of 5 countries. Only 1 country surveyed mentioned it has Earth Sciences specialists teaching at lower-secondary level.

As at primary level, most -even more- lower secondary science teachers are trained through university degree programmes -81%, 13 countries- followed by teacher's college programme -25%,of 4 countries, 12% of 2 of those surveyed must complete a probationary teaching period, whilst 6% of 1 country, must complete a mentoring or induction program and 31% of 5, are trained through other type of methods.

The pattern of support available to teachers of lower secondary natural sciences is very similar to that available to primary science teachers, though it is worth mentioning that support such as "national initiatives focusing on the initial teacher training of science teachers" duplicates while "teacher education programmers dealing with gender" decreases almost a half. These measures include:

- Public policies for the promotion of science education that include the improvement of science teacher education -50 of 8 countries-;
- Specific continuing professional development (PD) activities provided by education authorities in their official training programmes for in-service science teachers the 50%, of 8 countries;
- National initiatives focusing on the initial teacher training of science teachers, 50%, of 8 countries;
- School partnerships, science centres and similar institutions that contribute to teachers' informal learning and provide advice -44%, 7 countries-;
- Teacher education programmes dealing with gender -i.e. considering the different interests of boys and girls, and avoiding gender stereotypes when interacting with students-, the 31% of 5 countries;
- Science centres that deliver formal continuing professional development (PD) activities for teachers -19%, of 3 countries-.

Earth sciences at lower secondary level

From the 16 countries that have national curriculums or standards, 15 (93%) include Earth Science in the lower secondary curriculum, whilst one country does not. In the opinion of the respondents from the 15 countries that have Earth Science in their lower secondary curriculum, the curriculum requirements are not followed very closely in 47% of the 7 countries, in 33% of 5, are followed quite closely while in 20% of 3 are followed very closely.

According to the survey responses, Earth science content is most frequently found in:

- Geography; Biology: 67% of 10 countries;
- Integrated natural science: 53% of 8 countries;
- Physics and Chemistry: 47% of 7 countries;
- Geology and Earth Science: 27% of 4 countries;
- Environmental sciences, Ecology, Earth and Space Sciences, Earth Systems Science
- In crosscutting concepts or core ideas: 20% of 3 countries;
- Natural environments and wildlife; Physical Geography and Integrated science subject: 13% of 2 countries; and,
- Geosciences: 7% of 1 country.

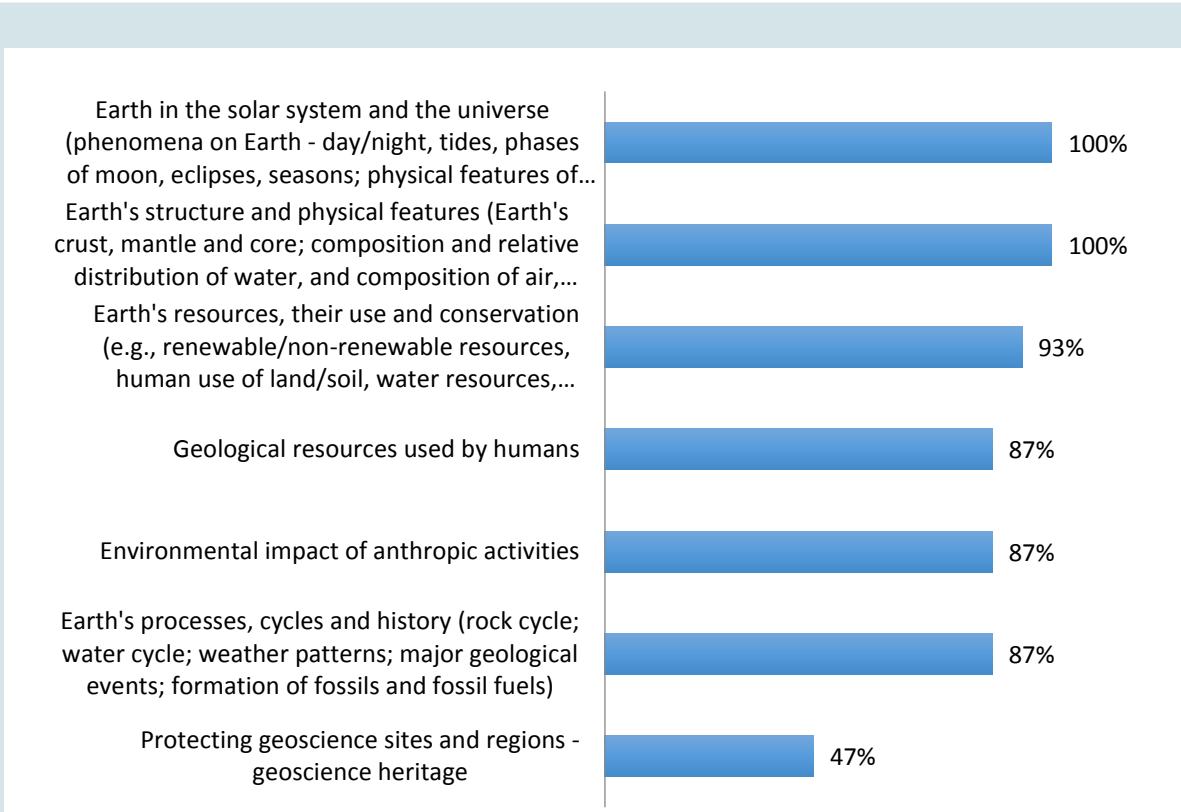
Graphic 30 shows the topics covered by lower secondary Earth Sciences as indicated by the survey. According to Graphic 29, equal weighting is given to the topics of *Earth in the solar system and physical features* and *Earth's structure and physical features* -100% each, 15 countries-. *Earth's resources, their use and conservation* is also quite important, 93% of 14 countries, followed by *Geological resources used by humans*, *Environmental impact of anthropic activities*, *Earth's processes, cycles and history*, 87% of 13 countries, and *Protecting geoscience sites and regions – geoscience heritage* aspects have a lower but still important profile 47% of 7 countries.

These topic areas have a greater emphasis on solid Earth sciences, are more wide-ranging than those at the primary curriculum are and seem to be complementary. These topics are taught as part of different sub-disciplines that are part of the curricula.

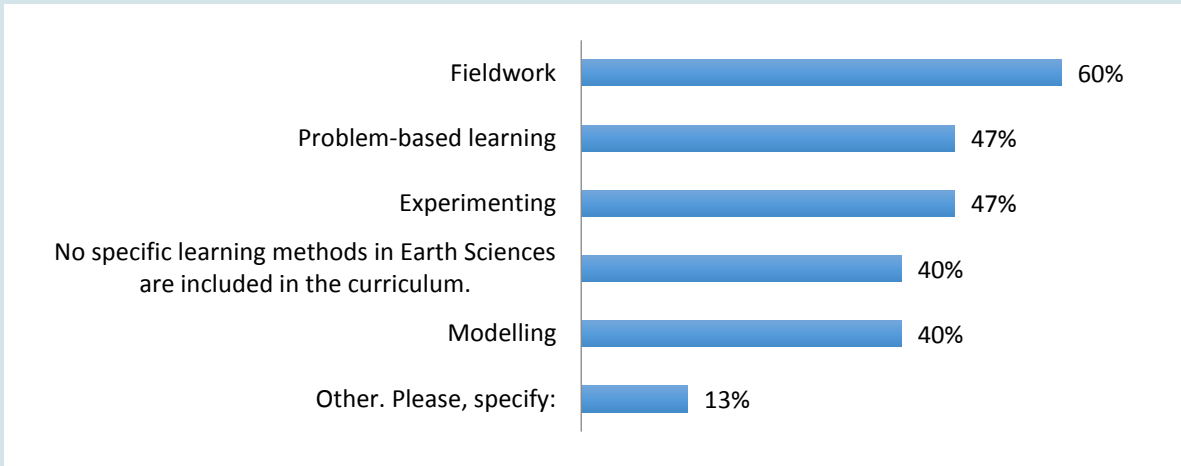
Earth Science sub-disciplines that form part of the curriculum are the following:

- Natural resources: 93% of 14 countries;
- Disaster risk: 87% of 13 countries;
- Earth science: 73% of 11 countries;
- Atmospheric sciences, Geography physical, Geology, Seismology, Volcanology: 67% of 10 countries;

Graphic 29: Topics taught by the end of lower secondary education according to the curriculum (Expert´s opinion, Latin American and Caribbean countries, n=15)



Graphic 30: Learning methods in Earth Science that included in the curriculum (Expert´s opinion, Latin American and Caribbean countries, n=15)



- Geography nature, Hydrology, Environmental sciences: 60% of 9 countries;
- Meteorology: 53% of 8 countries;
- Climate studies, Space and Planetary Sciences, Soil Science: 40% (6 countries)
- Mineralogy: 33% of 5 countries;
- Geoscience, Oceanography, Palaeontology: 27% of 4 countries; and
- Geographic information systems (GIS), Geophysics, Hydrogeology, Marine science, Ocean life sciences: 7% of 1 country.

Among the 15 countries that answered the questionnaire there is a range of different learning methods included in the teaching of lower secondary Earth science. As Figure DG 9 shows, whilst more than a third (40%, 6) of the curricula require no specific learning methods more than half (60%, 9) requires fieldwork, 47% (7) uses problem-based learning as well as experimenting methods. 40% (6) uses modelling and 13% (2) other methods such as case study, observation and map. So active learning in lower secondary Earth sciences is widely spread.

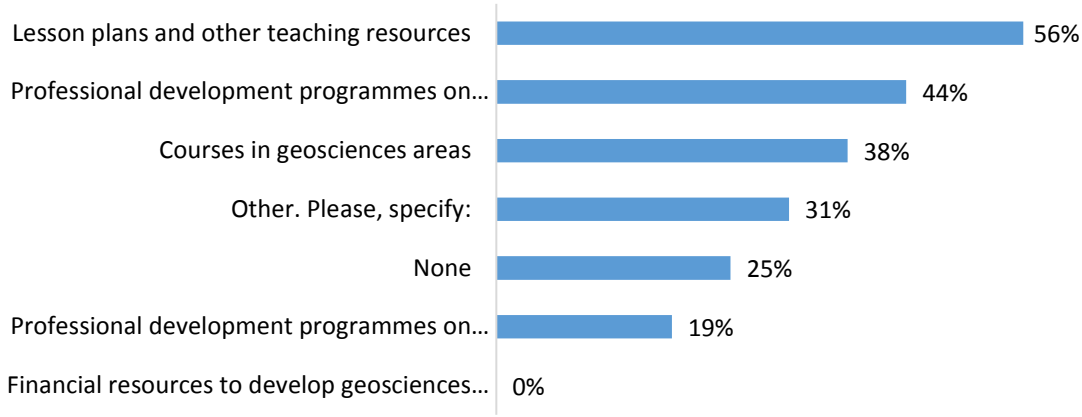
In assessment, only 2 (13%) of the countries that use standardized procedures in Natural Sciences reported that standardised assessments contain specific questions on Earth sciences. In 6 (40%) of the cases, there are questions about Natural Sciences in general and, in 2° (13%), there are general questions about physical sciences in general including chemistry, physics and earth sciences.

Graphic 31 displays information about preparation and support given to lower secondary Earth science teachers. Experts from the 16 surveyed countries indicate that in more than half of the cases teachers have access to *lessons plan and other teaching resources*, 56%, of 9 countries. In less cases, they have access to *professional development programmes in science teaching*, 44%, of 7 countries, to *courses in geosciences areas*, 38%, of 6 countries, and finally to *professional development programmes in geoscience teaching*, 19%, of 3 countries. No country has access to *financial resources to develop geosciences materials and/or acquire supplies for instruction*.

Things look different when comparing with the support offered to primary teachers of Earth science at primary level (see Graphic 27), courses in geoscience education are available to 38% of 6 countries of the teachers while professional development programmes on geoscience teaching reach 19%, of 3 countries. However, no teachers have access to financial resources to buy geoscience materials in both levels.

Teaching materials supporting Earth Science teaching at lower secondary level are available in 81% of 13 countries, among 16 responded countries, but three countries do not have access to these materials. These resources, according to the experts, are of moderate, 56% of 9 countries or high quality, 13% of 2 countries.

Graphic 31. Support provided for teachers of lower secondary Earth science (Expert´s opinion, Latin American and Caribbean countries, n=16)



Only one country (6%) has poor-quality materials. This differs from what happens at primary level where most of the materials are of moderate quality. Finally, 25% of 4 countries, of the surveyed countries do not have teaching materials available to support Earth Sciences teaching.

Lower Secondary Education: natural sciences curriculum, assessment and teaching

The responses from 16 countries indicated that in 13 (81%) countries, there is a compulsory national curriculum or program covering Natural Sciences in upper secondary education, and in 3 (19%) of them, there are national standards or guides that cover Science. No country has Natural Sciences curriculum or national standards implemented at sub national level and none of these countries lacks a science curriculum covering science teaching.

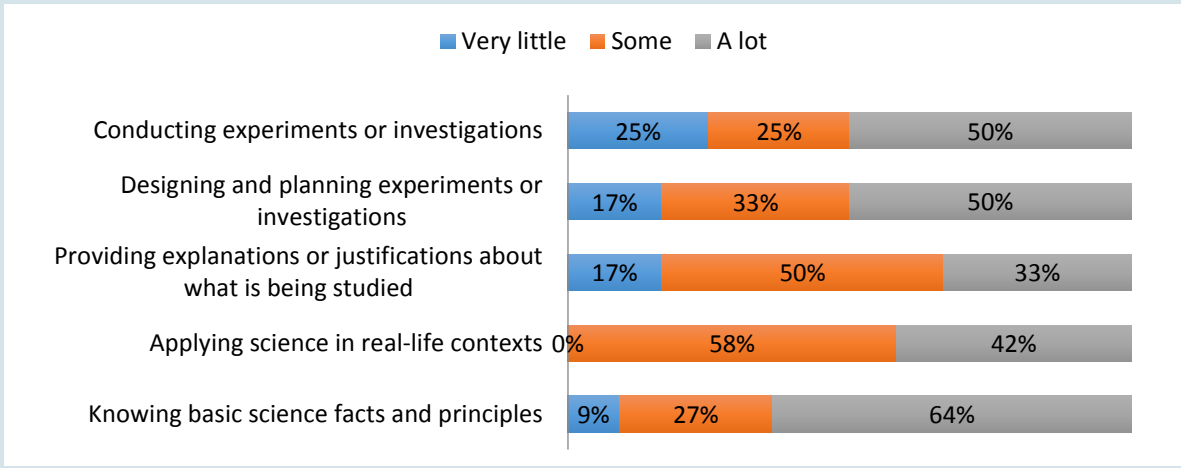
In most of countries, 75%, of 9, where there is a compulsory national curriculum or national standards that cover Science, there is a multiple branching system with specialist branches or streams of education open to students among 12 countries. In 83% (10 countries) of the cases, all students can access tertiary education in science, whereas in 17% of 2 countries, of them, only students choosing scientific branches can access tertiary education in Science.

According to experts, in 58% of 7, the countries surveyed, although there are multiple branches, Natural Sciences subjects are compulsory for all students. For those students who do not choose natural sciences branches, the natural sciences subject they take are Biology, 75%, of 9 and Physics, 67% of 8 countries, Geography and Chemistry - 50%, 6 countries-, Ecology -25%, 3 countries- Earth Sciences, Environmental Sciences and Biochemistry -8%, 1 countries-.

For students who choose Natural Sciences branches, the branches available to them include: Biological and related sciences -biology and biochemistry-, 92%o f 11 countries; Physical sciences -chemistry, earth sciences, and physics-, 83% of 10 countries; and Environmental sciences -ecology and environmental sciences- 25% of 3 countries.

The main emphases of the curriculum by the 12 countries with multiple branching systems are shown in Graphic 32. Graphic 33 shows that many countries give a *lot* -64%, 7 countries- emphasis to *knowing basic science facts and principles.* Most of them also give *a lot* of emphases -50%, 6 countries- to *designing and planning experiments or investigations* and to *conducting experiments or investigations*. There are also those that give *some* emphasis -58%, 7 countries- or a *lot* -42%, 5 countries- to *applying science in real-life contexts*.

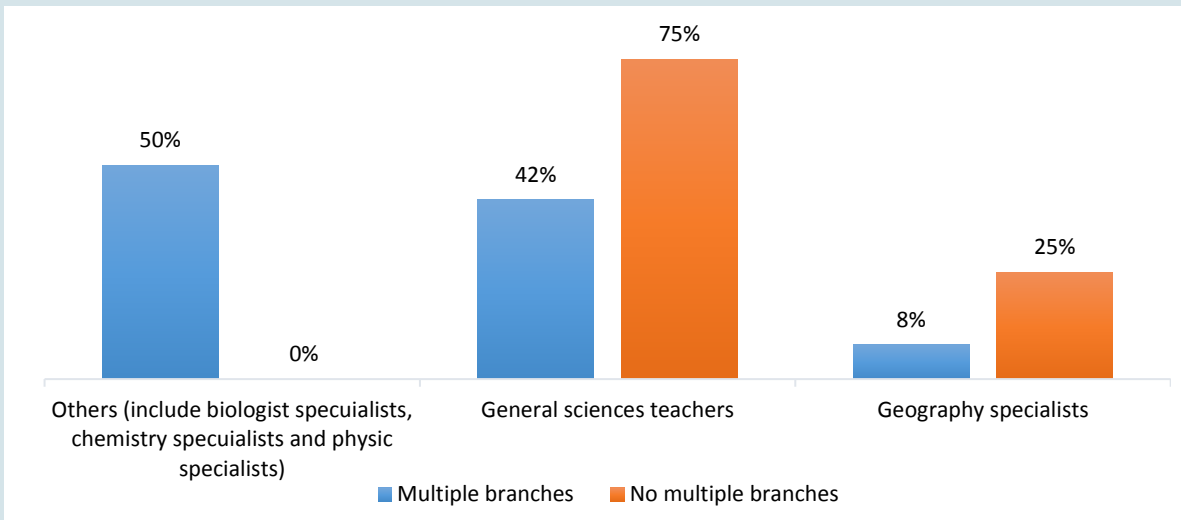
Graphic 32. Main emphases to the Natural Science curricula for upper secondary education (Expert´s opinion, Latin American and Caribbean countries)



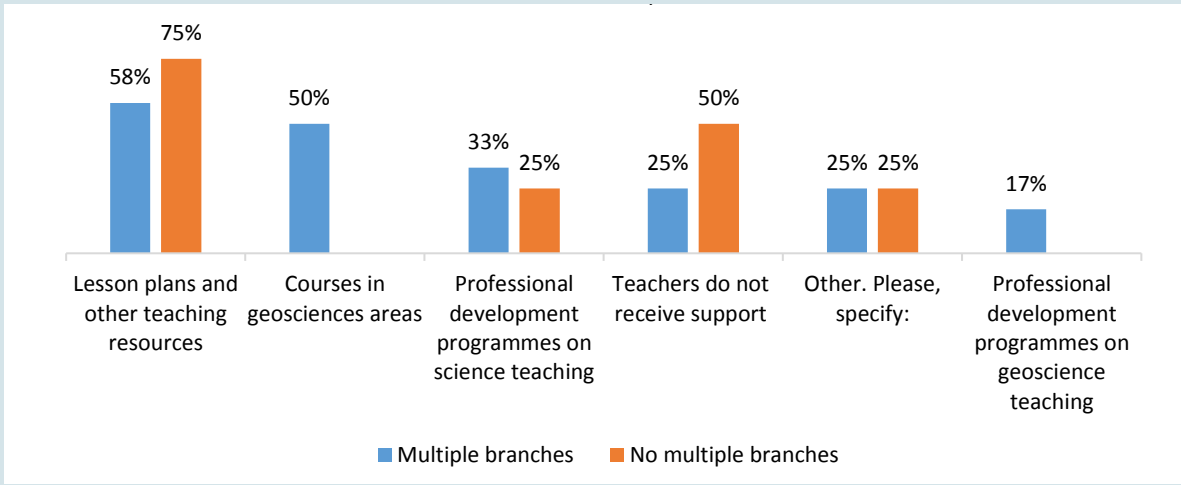
Graphic 32 shows that the trend from primary science (Graphic 24) through lower secondary science (Graphic 28) continues, of continuing strong emphasis on knowing facts and principles and applying science in real life context. Fluctuations appears among designing and planning experiments or investigations and to conducting experiments or investigations.

Regarding students´assessment experts responses indicate that of the 81% (13) of the countries that have guidelines for the assessment in the natural sciences. In most of these countries, most commonly used methods for student assessment are traditional written or oral examinations -88%, 14 countries- and students' performance in class (56%, 9 countries-, followed by project-based work -44%, 7 countries- and fieldwork -13%,

Graphic 33. Profile of Earth Science teachers at upper secondary level (Expert´s opinion, Latin American and Caribbean countries, n=16)



Graphic 34. Support given to upper secondary teachers for their teaching of Earth Sciences (Expert´s opinion, Latin American and Caribbean countries, n=16)



2 countries-. This shows a very similar pattern to that at primary level and lower secondary level, with examinations being the most commonly used technique, followed by student performance and project-based work, with fieldwork assessment having a low profile.

The 44%, 7 of countries of countries that have a compulsory national curriculum or national standards that cover Science assess upper secondary science through compulsory national tests and a further 6% of 1 country, through non-compulsory national tests. International testing is used in around a third of countries -36%, 4 countries compulsory and non-compulsory-, in 11 reposed countries, less than at lower secondary level. Most countries, student assessment data is mainly used for students' evaluation, 57% of 9 countries, while secondary uses include statewide monitoring 44%, 7 countries), teacher appraisal, 31% of 5 countries, accreditation-system, 19% 3 of countries.

All 16 countries surveyed provided data on the teaching of natural sciences at upper secondary level. Almost all the countries, -94% of 15. have specialist natural science teachers at upper secondary level, a higher percentage than lower down the schools. Still, almost 70% of 11, of the countries have not implemented methods to recruit or retain natural science teachers.

The pattern of the preparation routes at upper secondary level is a little bit different to that at lower secondary level; university degree -81%, 13 countries, teacher college program -19%, 3 countries-, passing a qualifying examination the 6% of 1 and other routes of preparation -25%, 4 countries-.

The support available to upper secondary natural is like that for lower secondary, except that education authorities provide more professional development at upper secondary level and there is slightly less emphasis on dealing with gender issues. They include:

- Public policies for the promotion of science education that include the improvement of science teacher education -63%, 10 countries-;
- National initiatives focusing on the initial teacher training of science teachers -56%, 9 countries-;
- School partnerships, science center's and similar institutions that contribute to teachers' informal learning and provide advice -44%, 7 countries-:
- Specific continuing professional development (PD) activities provided by education authorities in their official training programmed for in-service science teachers -44%, 7 countries;
- Science center's that deliver formal continuing professional development (PD) activities for teachers -31%, 5 countries-; and
- Dealing with gender (i.e. considering the different interests of boys and girls and avoiding gender stereotypes when interacting with students) is addressed in teacher education programmed -25%, 4 countries-.

Earth sciences at upper secondary level

According to expert's opinion, among the 4 countries with no multiple branching systems, 50% (2) of the countries said the curriculum prescribe the percentage of total instructional time to be devoted to Natural Sciences. In two countries, Earth Sciences form part of the curriculum, mostly as part of an integrated natural science course or geography course. Moreover, they include the following sub disciplines: Natural resources, Natural hazards, Environmental sciences, Geography, and Ecology (100%); followed by Geology, Geomorphology, Fossils/ Paleontology, Meteorology, Biogeography, and Hydrology, 50% of 2 countries.

Also, in the 4 of countries with no multiple branches systems, the surveyed countries in which Earth Sciences form part of the curriculum give *very little* or *some* guidance to students to investigate issues in Earth Sciences , 50% of 2 countries in total, and information about Earth Sciences-related careers intentionally included in instruction is done in a very little or some extent , 50% of 2 countries in total.

Among the 12 countries with multiple branching systems, in 67% of 8 countries the curriculum prescribes the percentage of total instructional time to be devoted to Earth Sciences for students who choose scientific branches. Respondents were provided with a list of Earth sciences related sub-disciplines and asked to indicate which of these formed a major part of the Earth science curriculum.

Earth Sciences sub-disciplines that form part of the curriculum are the following;

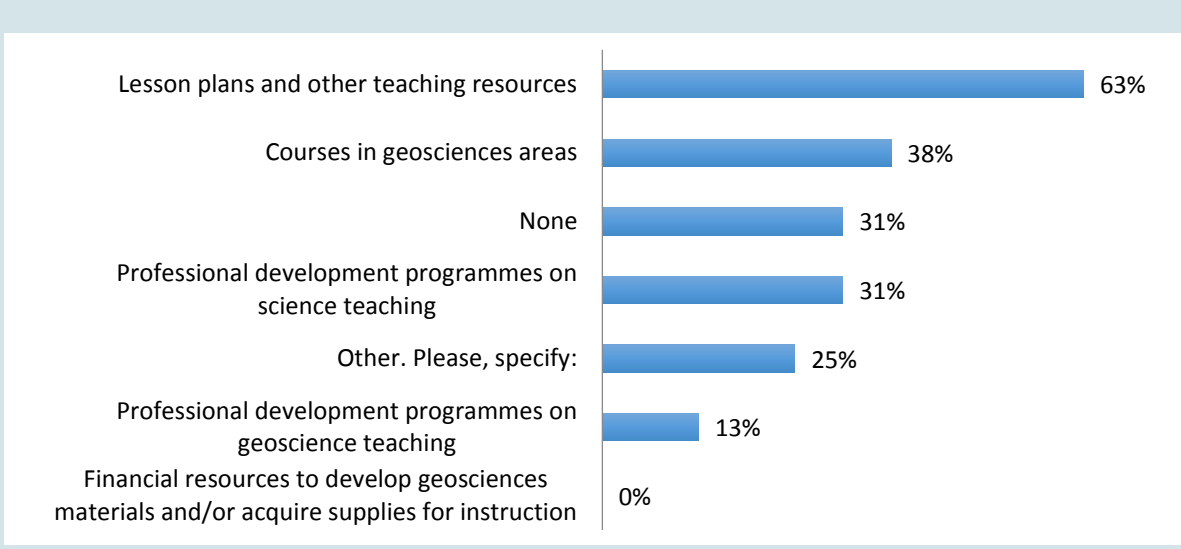
- Geology, Atmospheric Science: 59% of 8 countries;
- Geography, natural and physical: 50% of 6 countries, each
- Climate Studies, Earth Science: 42% of 5 countries;
- Hydrology: 17% of 2 countries;
- Geographic Information Systems (GIS), Geoscience, Geophysics: 8% of 1 country.

In the opinion of the respondents from most of the countries with multiple branching systems, in the case of Natural Sciences branches, Earth Sciences content of the curriculum is not very closely followed in most schools 42% (5) of the countries, and quite closely in 33% (4). It is followed very closely in 17% (2), and it is largely ignored in 8% (1).

Noticeable, in the case of Natural Sciences branches, students are generally encouraged and or guided to investigate Earth sciences issues through the curriculum in *very little*, 50% of 6 countries, cases. 25% of 3 of students have *some* guidance, but few students, 8% of 1 country receive *a lot* of guidance in the Earth sciences direction.

Regarding tertiary education, information intentionally included in the instruction about Earth Sciences careers is *very little*, 50%, 6 countries. In 17% of the cases students of Natural Sciences branches receive *some* infor-

Graphic 35: Support given to upper secondary teachers for teaching Earth Sciences (Expert´s opinion, Latin American and Caribbean countries.



mation and a quarter (25% of 3 get *none*. 8% of 1, of the students obtain a lot of information.

Concerning assessment in Earth Sciences, countries with standardized procedures in Natural Sciences, in 38% of 6, the countries surveyed there are specific questions about Earth Sciences; in 31% of 5 countries, there are no standardized procedures. However, there are general questions about physical sciences in general including Chemistry, Physics and Earth Sciences in 25% of 4 countries of the cases, while in 6% of 1 country there are questions about Natural Sciences in general.

Regarding teaching in Earth Sciences, in countries with multiple branches system, the approach to the teaching at upper secondary level can be summarized as generally taught mostly by general science teachers, 50%, 8 countries, and geography specialists (13% of 6 followed by others ,38% of 6 countries, mostly including, Chemistry, Physics, and Biology.

In most countries, teachers are prepared and supported with respect to teaching Earth Sciences topics through: lesson plans and other teaching resources, 62% of 10 countries; professional development programs on geoscience teaching, 38%, of 6; professional development programs on science teaching, 31% of 5 countries; no support at all, 31% of 5 countries; others, 25% of 4 countries. They neither receive any financial resources to develop geosciences materials and/or acquire supplies for instruction

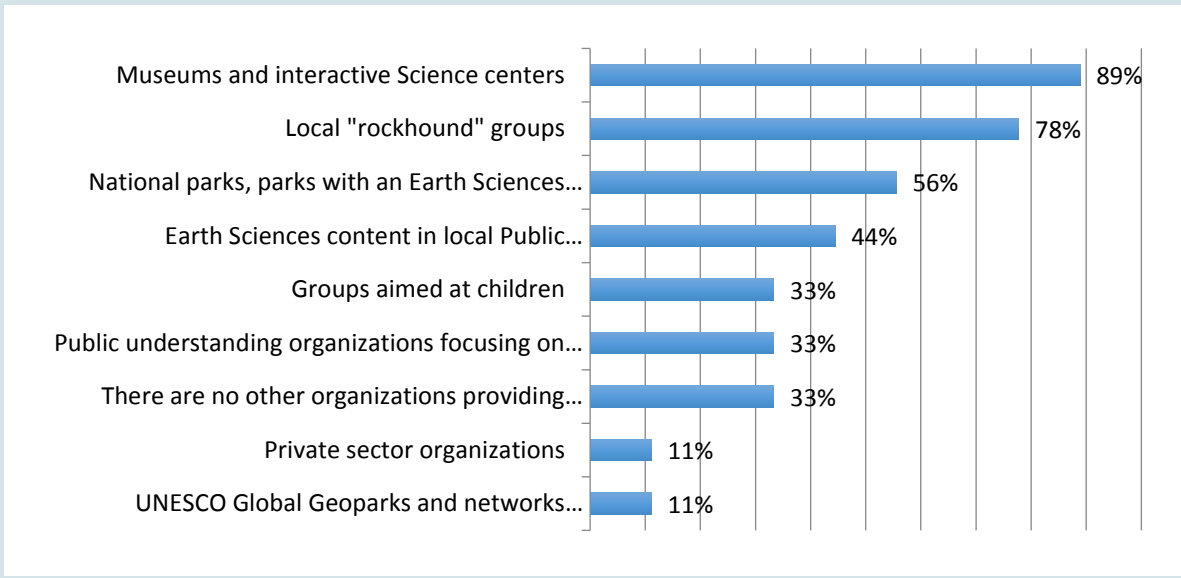
The pattern in Graphic 34 is different from that at lower secondary level (Graphic 32). The support given to lessons plans and teaching resources is the highest in both cases, and courses in geosciences areas have the same support, less than % (2 countries) of teachers of Earth science have access to professional development programmed on geoscience teaching and 31% (5 countries) do not receive any support.

Earth science teaching materials are available 81% (13) of the 16 countries surveyed. In most countries the quality of these teaching materials is moderate, 62%, 10 countries. or high. 12%, 2, of it only two countries reporting poor quality (12%) and other two reporting there are no materials to support the teaching of Earth Sciences. This seems to be an improvement from primary level, taking into consideration there are more countries with teaching materials for the teaching of Earth Science available.

Extracurricular activities & innovations

From the 16 countries surveyed, more than half of them, 56% of 9 countries, have guidelines or recommendations in place encouraging schools to provide extra-curricular activities in natural sciences. The main organizations providing students with activities that go beyond schools in these countries are shown in figure Graphic 36:

Graphic 36: Organizations providing students with activities that go beyond schools (Expert´s opinion, Latin American and Caribbean countries, n=9)



Noticeably, in 50% (8) of the surveyed countries there are regular national events of a range of different types held for the promotion of Earth sciences. In their free responses, they mentioned the fact that these activities ultimately depended on the annual budget available. It was also mentioned, that these activities were generally organized in the framework programmed related to the environment in general as well as through Geography Symposiums and National Geography Congresses. Experts also mentioned The National Science and Technology Fair (FENCYT), which is organized annually, and activities that engage the public in the observance of earth day, ocean day, science day, etc.

Regarding their focus, according to expert´s opinions, in general these events are:

- Open to public, although pupils and students are the main target and specific activities are arranged for them: 37% of 6 countries,
- Focused solely on the school population: 12% of 2 countries;
- Science promotion events are targeted specifically at schools: 6% of 1 country;
- There are no nationwide events for the promotion of Earth Sciences: 43% of 7 countries.

Of the 15 countries responding the survey, 67% of 10 countries, reported the existence of research groups on Earth science education. Only a small amount of countries, 25% of 4 countries, participate in national Earth science Olympiads among 16 countries. And five countries reported on the importance of these events in their free responses (14%).

According the 15 countries that responded the innovation part, less than half of the countries, 40% of 6, reported innovations in the teaching of Earth science in the past ten years. In their free responses, seven of the countries reporting innovations, 33%, of 5, indicated that this was in response to curriculum change, whilst three countries, 13% of 2, reported the development of new curriculum materials for Earth science teaching.

Among 15 countries responded, in almost two thirds of the countries, 73% of 1, Earth science educators have promoted or influenced social change, for example, petitions or actions on issues of: protection/ remediation of pollution; conservation/ sustainable exploitation of natural resources; protection of the landscape/ areas of geological interest; among others. In free responses, 2 (13%) countries noted the development of Geoparks and UNESCO world heritage sites, whist 1 (7%) countries noted the importance of promoting geosites.

Final remarks

Science education

According to experts from the 16 countries surveyed in Latina America and the Caribbean, most countries -93%, 15 countries- reported that a range of national policies are in place to raise the profile of natural science in education, with only one country indicating no such national policy developments. These policies had a wide range of drivers, goals and approaches, but the most important approach across the Latin America -73% of 11- has been curriculum reform, among 15 countries responded in this question.

The reporting from across Latin America and the Caribbean at primary, lower secondary and upper secondary level on how much emphasis is placed on the curricula showed an important focus on the knowledge of basic science facts and principles and knowing basic science facts and principles. Also, an important emphasis is placed on applying science in real life context. Design and plan experiments or investigation is important in primary level, decreases in lower secondary and again gains importance at upper secondary level. Conducting experiments or investigation decreases in secondary teaching.

In expert´s opinion, most countries had guidelines for assessment in the natural sciences, based mainly on traditional written and or oral exams, students' performance in class and on project based – work.

The number of specialist secondary science teachers in the natural science increased up the school, 25%, 4 countries at primary; 88%, 14 countries at lower secondary; 94%, 15 countries at upper secondary. While there is a lowest ratio of natural science specialist teachers at the primary level, only 6%: One of the countries surveyed have implemented policies to recruit or retain them. This increases to 13% of 2 at lower secondary level and to 31%of 5 countries at upper secondary level. At all levels, most teachers are trained though university degree programmes and teacher college programmes, whilst less than 10% on average must complete probationary periods or mentoring or induction program in school.

Table 37. The views of respondents on how closely the national curriculum guidelines in Earth science are followed.

The opinions of respondents		Primary (n=13)	Lower secondary (n=15)
The Earth science curriculum guidance is:	Followed very closely	0%	20%
	Followed quite closely	62%	33%
	Not very closely followed	38%	47%
	Largely ignored	0%	0%

At all levels in most countries there are public policies focussed on the promotion of science education that include the improvement of science teacher education with professional development provided by education authorities and national initiatives for initial teacher training. Regarding gender issues: dealing with gender (i.e. considering the different interests of boys and girls and avoiding gender stereotypes when interacting with students) is addressed in teacher education programmes diminish from primary level -51%, 8 countries answered they have policies considering gender- to lower secondary 31% of 5 and to upper secondary level, 25% of 4.

Earth science education

In this survey, all 16 countries indicated that they had a curriculum covering natural sciences at primary, lower secondary levels and upper secondary levels.

Among the 15countries that answered the questionnaire (n=16), 13 countries indicated they have Earth Science in their primary curriculum (87%) whilst two countries do not.

Regarding the data at lower secondary level, all 16 countries surveyed indicated that they do teach lower secondary Earth science, 94%, 15 countries.

At upper secondary level, the Earth science content of the curriculum is more difficult to establish from the current survey since the survey shows that a multiple branching system is adopted with specialist branches or streams of education open to students. In this scenario, from the 16 countries surveyed, 75% of 12 have a multiple branching system where natural science is compulsory while 25% of 4 do not. For students who choose scientific branches in multiple branching system, 67% (8) of the countries said that the curriculum prescribes the percentage of total instructional time to be devoted to Earth Sciences.

In addition, in the current survey, respondents were asked if, in their opinion, the curriculum guidance in Earth science was closely followed or not. Their responses are shown in Table 37. The Table 37data shows that the Earth Science coverage of curricula across the Latin America is variable, with few numbers of countries having no reported-on Earth Science curriculum; for those countries that do have Earth Science curriculum guidelines, these are not followed very closely in a significant number of countries.

For countries that do teach Earth science, the scope of the Earth science taught changes up the curriculum. The Earth science subject areas comprising more than 30% of the curriculum at each level are shown in Table 38. The data in Table 38 shows that Natural Resources form a key component of study at secondary levels. Whilst Disaster risks, Earth Sciences and Geology as subject areas, form important components of the curriculum. In primary level, Biology and Geology are the most important components of the curriculum.

Table 39 shows the percentages of countries with Earth science questions in their assessments. As Table 39 shows, more than half of countries do have Earth-science specific questions in their assessment procedures, and this situation is better in the upper level schools.

The support available to teachers of Earth science at different teaching levels is summarised in Table 40. As Table 40 shows, specific geoscience support is only available in a little bit more than one third of the countries surveyed, whilst financial support for Earth science teaching is not available in all the countries surveyed.

Table 38. Components forming more than 30% of the curriculum at each level

Primary (n=13)	Lower secondary (n=15)	Upper secondary (n=14)
Water on Earth – 100%	Natural resources – 93%	Natural resources – 84%
Solar system – 100%	Disaster risks – 86%	Environmental sciences – 75%
Weather – 100%	Earth sciences – 73%	Hydrology – 67%
Day/night and Earth's rotation – 100%	Atmospheric Sciences – 67%	Disaster risks – 67%
Landscape – 92%	Physical geography – 67%	Geology – 58%
Climate change - 91%	Geology – 67%	Atmospheric Sciences – 58%
Environmental risks – 77%	Seismology, Volcanology – 67%	Climate studies – 42%
Soil erosion – 70%	Geography (natural) – 60%	Natural Geography – 50%
Fossils – 62%	Hydrology – 60%	Physical Geography – 50%
Geological resources and heritage – 62%	Environmental sciences – 60%	Seismology, Volcanology – 50%
	Meteorology – 53%	Hydrogeology – 17%
All available options in the questionnaire were indicated at more than 30%	*12 of the options available in the questionnaire were indicated at less than 50%*	*21 of the options available in the questionnaire were indicated at less than 50%*

Table 39. Percentages of countries with specific Earth-science-related questions in the standardised assessments.

Percentages of countries with Earth science questions in their assessments	Primary (n=14)	Lower secondary (n=15)	Upper secondary (n=16)
	57%	67%	69%

Table 40. Support provided to teachers of Earth science.

Support provided	Primary (n=16)	Lower secondary (n=16)	Upper secondary (n=16)
Professional development programmes on science teaching	31%	44%	31%
Lesson plans and other teaching resources	69%	56%	63%
Courses in geoscience areas	19%	38%	38%
Professional development programmes on geoscience teaching	6%	19%	13%

Table 41. Availability and quality of Earth science teaching material.

Earth science teaching material		Primary (n=16)	Lower secondary (n=16)	Upper secondary (n=16)
Percentage of countries where Earth science teaching material is available		75%	81%	81%
The quality of Earth science teaching material is:	High	6%	12%	12%
	Moderate	69%	56%	62%
	Poor	0%	6%	12%
	Not applicable	25%	25%	12%

Table 41 summarises the availability and quality of Earth science teaching material available in the countries, which contributed to the survey. Table A5 shows that in general, one fifth of the countries surveyed, has no teaching materials for the teaching of Earth sciences; these presumably are the countries with little or no Earth science in their curriculum. However, in most countries the quality of materials is moderate, with high quality materials being used only a few countries.

Finally, for Latin America and the Caribbean other significant findings relating to Earth science in the current survey are as follows.

- In most countries where Earth science is studied, the primary curriculum tends to focus on the atmosphere, Climate and Earth in space; this continues up the curriculum, with an increasing emphasis on solid Earth sciences and Earth resources, their use and conservation, which is quite like the rest of the world.
- In general, the countries surveyed have Earth science-related questions in their assessments.
- Specific support for geoscience teaching is available in less than half the countries
- No financial support for the teaching of Earth science is provided in all LAC countries surveyed, according to experts.
- In most countries the quality of teaching material available for the teaching of Earth science is only of moderate quality and is poor in a significant minority of countries, however, this did show a small improvement on the textbook-quality data from the 2013 survey.


General view
of geoscience
education
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María Frick
Consultant,
International Geoscience and Geoparks Programme – IGGP,
Regional Office for Science in Latin America and the Caribbean,
UNESCO Montevideo

The opinion survey carried out by UNESCO and IGEO provides a general background to school-level geoscience education across the world whilst highlighting important aspects of Geoscience education today. Following the detailed descriptions and discussions of Chris King and Denise Gorfinkiel, it is possible to identify some specific issues and opportunities. These findings are presented below according to the objectives guiding the project "Building a community vision for education Earth Sciences in Latin America and the Caribbean" (see Introduction). Although the data is not conclusive, we hope that this information will provoke new analyses together with innovative proposals for collaboration.

Policies, strategies and programs for the promotion of Geoscience education

According to expert´s opinions, there are similarities across the regions regarding the type of measures being implemented for raising the profile of Science in education (see Table 42). In general, the most common strategy is curricular reform, followed by continuing professional development programs for teachers and, thirdly, the setting up of science centers and cooperation with universities involved in teacher's education. A difference between geographic regions relates to the creation of partnerships between schools, companies, scientists and research centers. Latin American and Caribbean countries seem to be at a disadvantage in the use of this method for the promotion of science education, which in the rest of the world seems to be great importance. These results therefore open the possibility for exploring these types of strategies, their best practices and achieved results, to discuss their compatibility and adaptability to regional scenarios in Latin American and Caribbean countries. Together with other advantages, these strategies can facilitate the setting up - within the general framework.

Of science education and the ongoing curricula - of specific programs for strengthening and promoting Geoscience education. A second opportunity is highlighted by strategies to promote the choice of university careers in

Table 42. Expert´s opinion on the policies implemented to achieve the main broad educational goals of national policies to raise the profile of Science in education, in countries that have national Natural Science curriculum or standards. (LAC=15, Non-LAC= 30)

	LAC	Non-LAC	Total
Implementing curriculum reforms	73%	83%	78%
Initializing projects focusing on continuing professional development for teachers	60%	57%	58%
Setting up science centers and other organizations	47%	57%	52%
Cooperating with universities to improve initial teacher education	47%	57%	52%
Creating partnerships between schools and companies, scientists and research centers	33%	67%	50%
Providing guidance measures to encourage more young people to choose scientific careers	33%	47%	40%

science. These strategies show small differences between regions but, for all countries, it is one of the least implemented strategies. It must be stressed, however, that this is the only strategy directly oriented to students alone. In a society in which one-to-one communication is a standard, it therefore be an alternative that is also worth exploring. Perhaps social networks and new media are opening doors that enable innovative approaches for encouraging people to choose the scientific - and geoscientific! - fields. This should clearly be encouraged.

The opinion survey also provided information on the activities that are being implemented to promote the teaching of Geosciences within current national curricula and strategies on Natural Sciences. This is highlighted through analyzing Geoscience extracurricular activities taking place in countries that have guidelines or recommendations for these types of programs in the Natural Sciences (see Table 43). Although there are general disparities between regions in this area, the differences are particularly large with respect to the organization of amateur geoscience activities such as "rock hound groups". These types of activities, which are reported as being strongly promoted in the other countries, are scarcely developed in Latin America and the Caribbean.

Another important difference is observed on the use of the UNESCO Global Geoparks as Earth Sciences teaching and learning platforms. The Latin America and the Caribbean region have joined UNESCO Global Geoparks Network more recently, so it is understandable that UNESCO Global Geoparks are not yet common educational tools in the region. Nevertheless, the disparity between regions demonstrates the potential of these UNESCO places, which in non-Latin American and Caribbean countries are among the five extracurricular activities of greatest development.

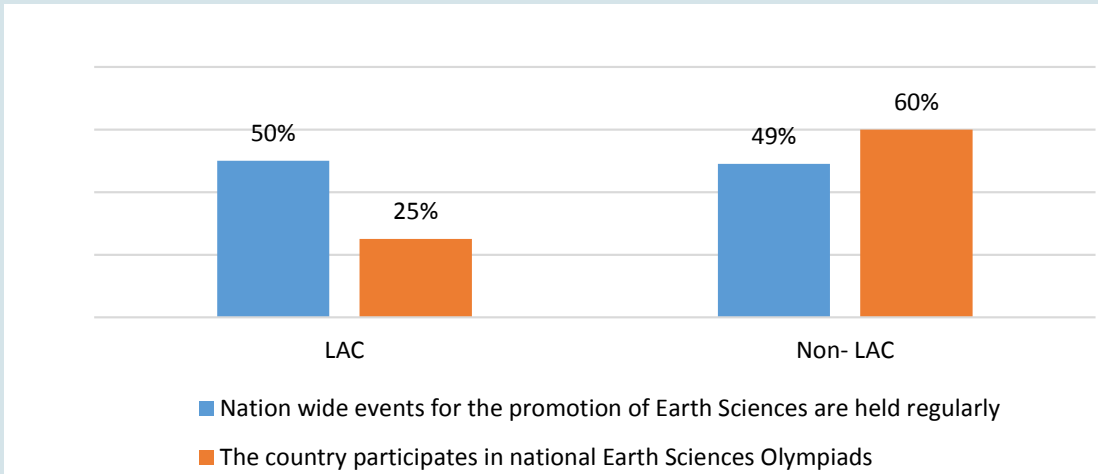
Furthermore, there are also differences between geographical regions regarding the creation of groups for children and work with private sector organizations. According to the expert opinion, these types of activities are less common in the countries of Latin America and the Caribbean than elsewhere. The existence of public understanding organizations focusing on Earth Sciences shows a similar disparity. Despite the importance of the management of Earth's resources in the public agenda, it seems Latin America and the Caribbean is not yet using the full potential of such approaches.

Finally, the organization of events for the promotion of Earth Sciences also shows differences (see Table 44). According to expert opinion, globally, approximately half of all countries surveyed regularly hold national events for the promotion of Geosciences. However, there is a noticeable difference between regions regarding partic-

Table 43. Expert´s opinion on the organizations providing students with activities that go beyond school in the field of Geoscience, in countries that have national guidelines or recommendations encouraging schools to provide extra-curricular or extra-program activities in Natural Sciences (LAC= 9, Non-LAC= 13)

	LAC	Non-LAC	Total
Museums and interactive Science centers	89%	85%	87%
Local "rock hound" groups	78%	23%	50%
National parks, parks with an Earth Sciences focus	56%	69%	62%
Earth Sciences content in local Public Understanding of Science Events	44%	54%	49%
Public understanding organizations focusing on Earth Sciences	33%	62%	47%
Groups aimed at children	33%	69%	51%
Other. Please, specify:	33%	23%	28%
UNESCO Global Geoparks and networks protecting sites of geological heritage	11%	62%	39%
Private sector organizations	11%	46%	29%

Graphic 44. Expert´s opinion on the organization of events for the promotion of Earth Sciences, in all surveyed countries (LAC= 16 countries, Non-LAC= 35 countries)



ipation in the International Earth Science Olympiad: only 25% of Latin American and Caribbean surveyed countries currently participate in this event, while this reaches 60% from other regions. The information is biased since IGEO members collaborated with the survey in non-Latin American and Caribbean countries - i.e. the 60% is not truly representative. However, it shows that only two countries of the surveyed countries in Latin American and the Caribbean region participate in this Olympiad and, consequently, that this event has great potential for further development.

Inclusion of Geosciences in the curricula and textbooks

Expert opinion indicates that most countries that have a curricula or national standards for Natural Sciences in primary (83%) and lower secondary (82%) education include Earth Sciences content in the science curriculum (see Table 45). However, they also indicate that only 58% of countries currently follow-up this curriculum "closely" or "quite closely" (LAC=62%, non-LAC=55%) (Table 46). In addition, the experts believe that in most cases the available materials for Geosciences teaching are of only moderate quality (see Table 47).

In primary education, teaching materials are available in 88% of the countries -77% in LAC, 95% in non-LAC-, being considered of moderate quality in 90% of the cases -100% in LAC, 84 % non-LAC-. In lower secondary education, materials are available in 86% of the countries -73% in LAC, 95% in non-LAC- and experts consider they are of moderate quality in 71% of those cases -82% in LAC, 65 % in non-LAC-.

Concerning upper secondary education, the expert opinions indicates lower levels of inclusion of Earth Sciences in the curricula or standards of Natural Sciences in Latin America and the Caribbean: 19% of countries with multiple branching systems include Earth Science content in their non-Natural Sciences branches -8% in LAC, 25% in non-LAC-. Nevertheless, these values increase if the inclusion of subjects such as Geography -50% in LAC, 46% in non-LAC- and Environmental Sciences -8% in LAC, 25% in non-LAC- among others are included, which have content linked to Earth Sciences. Regarding scientific branches, 50% of the cases include Geosciences content in their Natural Sciences branches, with values of 67% and 42% for LAC and non-LAC respectively. The experts believe that in 83% of cases there are Geosciences teaching materials available -5% in LAC, 90% in non-LAC-, but that in more than half of these cases (67 %) they are of only moderate quality.

Table 45. Percentage of counties including Earth Sciences in their Natural Science curriculum or standards at the national level, in countries that have national Natural Science curriculum or standards

	LAC	Non-LAC	Global
1. Primary	87%	80%	83%
2. Lower secondary	94%	75%	82%
3. Upper secondary, non-multiple branches	50%	67%	60%
4. Upper secondary, multiple branches: Natural Science branches	67%	42%	50%
5. Upper secondary, multiple branches: non-Natural Science branches	8%	25%	19%

Samples: 1.LAC 15 countries, non-LAC 25 countries; 2. LAC 16 countries, non-LAC 28 countries; 3. Lac 4 countries, non-LAC 6 countries; 4. LAC 12 countries, non-LAC 24 countries, 5. LAC 12 countries, non-LAC 24 countries. Please note that countries with federated curricula are not included in the analysis.

In general, it is striking that in most cases and for all educational levels, experts believe the available Geoscience teaching materials are of only moderate quality (see Table 48) This clearly points to the opportunity for supporting the implementation of existing Earth Science curricula through the production and dissemination of high-quality materials supporting Geoscience, particularly in Latin American and Caribbean countries. In primary education, such support can help students who will not end up choosing scientific areas in secondary or tertiary education to acquire knowledge for better participation in future democratic debates on Earth's resources. It is also a way to awaken Geoscience vocations among students who may later choose Natural Sciences either in secondary or tertiary education. In upper secondary education, the improvement of the available teaching materials and information on tertiary studies is crucial in scientific branches, since they influence many of the students who plan to choose university careers in Sciences. A more solid knowledge of Geoscience will not only increase the number of vocations in this area but will also help to facilitate interdisciplinary dialogues and exchanges among future scientists during their professional careers.

Table 46. Percentage of countries that follow the Earth Science curriculum "closely" and "quite closely", in countries that include Earth Sciences in their national Natural Science curriculum or standards.

	LAC	Non-LAC	Global
1. Primary	62%	55%	58%
2. Lower secondary	53%	67%	61%
3. Upper secondary, non-multiple branches	50%	25%	33%

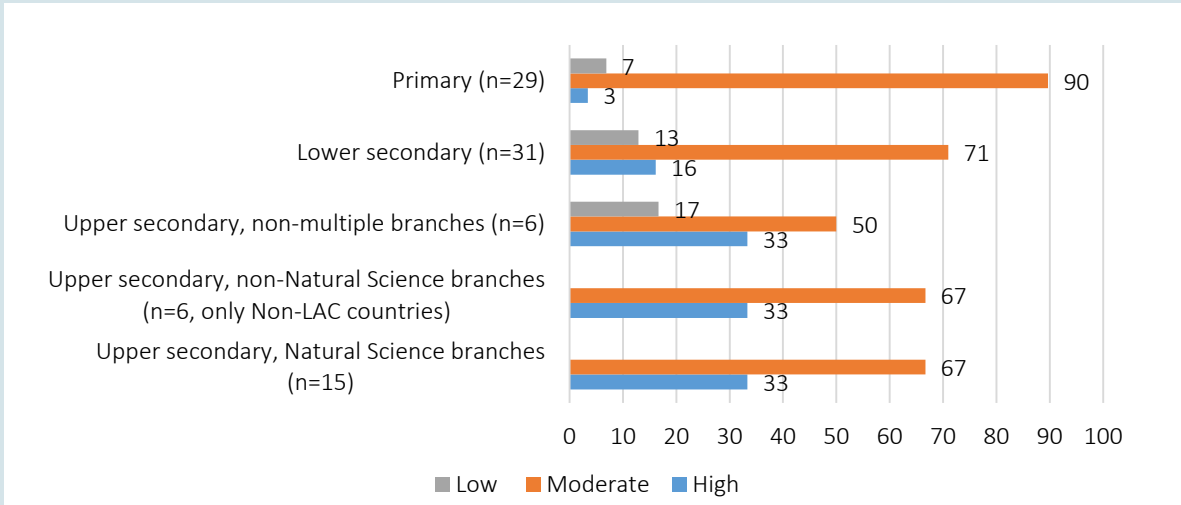
Samples: 1.LAC 13 countries, non-LAC 20 countries; 2. LAC 15 countries, non-LAC 21 countries; 3. LAC 2 countries, non-LAC 4 countries; 4. LAC 8 countries, non-LAC 10 countries, 5. LAC 1 countries, non-LAC 6 countries.

Table 47. Expert´s opinion on the availability and quality of teaching materials in Earth sciences (Expert´s opinion, countries that include Earth Sciences in their Natural Science curriculum or standards at the national level)

	% of countries in which teaching materials are available for the teaching of Earth sciences*			% of countries in which quality of the available teaching materials provided is "moderate" **		
	LAC	Non-Lac	Global	LAC	Non-Lac	Global
1. Primary	77%	95%	88%	100%	84%	90%
2. Lower secondary	73%	95%	86%	82%	65%	71%
3. Upper secondary, non-multiple branches	100%	100%	100%	100%	25%	50%
4. Upper secondary, Natural Science branches	75%	90%	83%	67%	67%	67%
5. Upper secondary, non-Natural Science branches	0%	100%	--	--	67%	--

* Samples: 1.LAC 13 countries, non-LAC 20 countries; 2. LAC 15 countries, non-LAC 21 countries; 3. LAC 2 countries, non-LAC 4 countries; 4. LAC 8 countries, non-LAC 10 countries, 5. LAC 1 countries, non-LAC 6 countries. ** Samples: 1.LAC 10 countries, non-LAC 19 countries; 2. LAC 11 countries, non-LAC 20 countries; 3. LAC 2 countries, non-LAC 4 countries; 4. LAC 6 countries, non-LAC 9 countries, 5. LAC 0 countries, non-LAC 6 countries.

Graphic 48. Expert´s opinion on the quality of teaching materials in Earth Sciences, in countries that include Earth Sciences in their national Natural Sciences curriculums or standards and where there are available teaching materials on Earth Sciences (Per



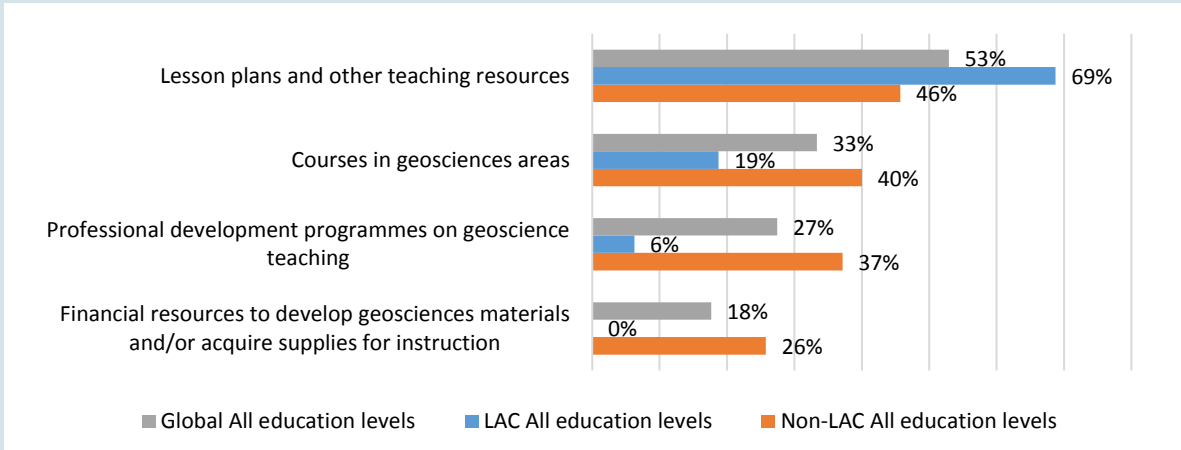
Characteristics of Teacher training in Primary and Secondary Education

In general, the expert opinion indicated that, at the primary level, most countries do not have teachers who teach only Natural Sciences -LAC= 77%, non-LAC=70%-, therefore they do not have specific training in this area. In lower secondary education, most countries have teachers who teach only Natural Sciences -LAC and non-LAC=71% each-, and the Earth Science content is generally taught by general science teachers or by specialists from other fields -LAC= 93%, non-LAC= 85%-. When considering all types of systems of upper secondary education, the majority of countries have teachers who teach only natural sciences -LAC= 94%, non-LAC= 77%- and the teaching of Geosciences is mainly carried out by general science teachers or teachers trained in other scientific areas -LAC = 50%, non-LAC = 69%- or by Geography teachers (LAC) = 12%, non-LAC = 16%).

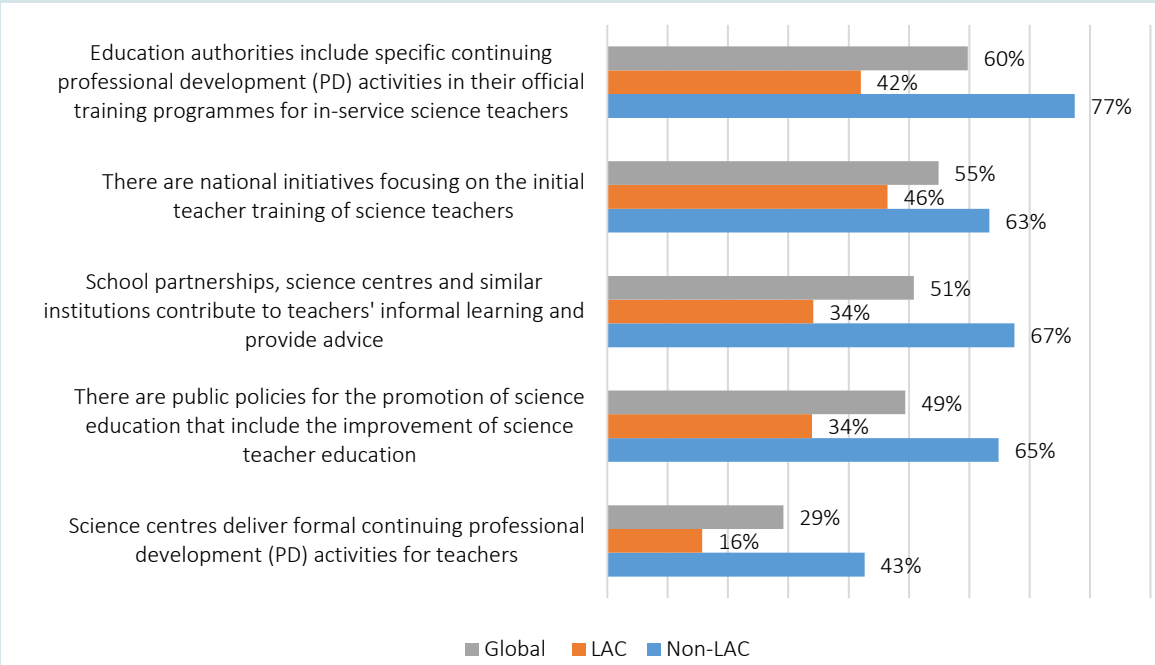
The expert opinion also highlighted some of the strategies implemented so far in supporting the teaching of Geoscience content at the different levels of education, i.e. the supports and tools that teachers currently receive to teach the Earth Science content of the national Natural Science curriculum or standards (see Table 49). In this regard, experts indicated a disparity between regions, both in the type of actions implemented and in the relative importance of each of these. In non-LAC countries, the different strategies have been implemented equitably, with the only exception, the granting of funds for the purchase or development of teaching materials. However, this financing strategy has been implemented at different educational levels: primary (25%), lower secondary (24%), science branches of upper secondary (30%), non-science branches of upper secondary education (50%). In Latin America, on the other hand, only three of the four mentioned strategies are used and - according to expert opinion - there is a predominance of "lessons plans and other teaching resources".

When asked for their opinion on whether countries provide tools and support for the teaching of Natural Sciences, experts again indicated differences between regions. In general, they believe that in Latin America and the Caribbean, fewer methods are being implemented for the training of teachers in Natural Sciences (see Graphic 50). The greatest difference is found in the inclusion of professional development activities in official training programs, although there are also some differences in the existence of national policies and programs in the area. A key finding in this regard refers to the creation of associations between schools, training centers and similar institutions, and to the implementation of training activities in science centers. Although these strategies have been less developed in Latin Amer-

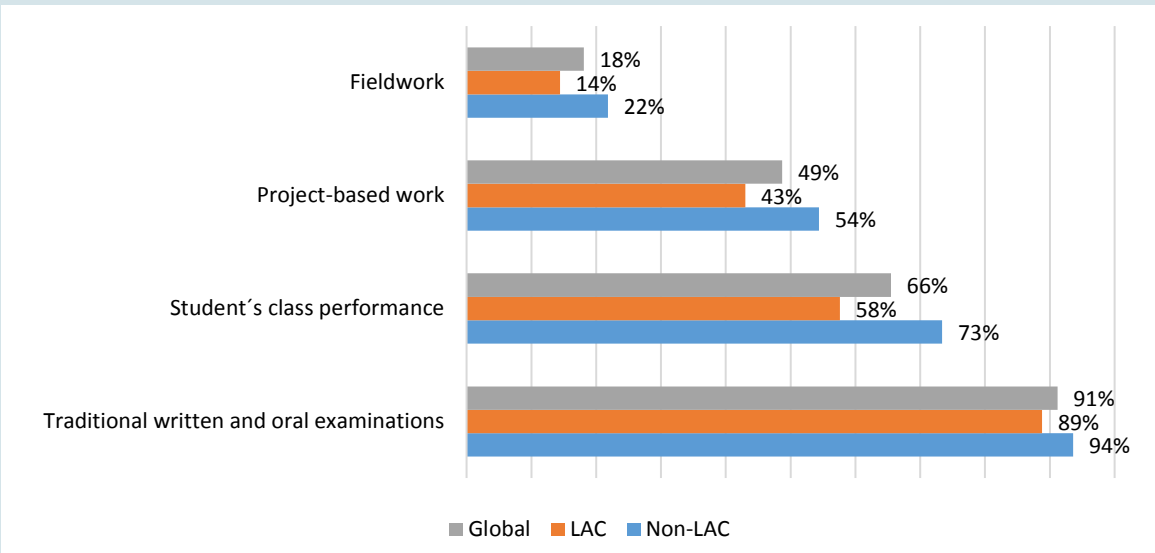
Graphic 49. Expert´s opinion on the preparation and support given to teachers for the teaching of Earth Science topics, in countries that include Earth Science in their national Natural Science curriculums or standars (Average for all education levels)



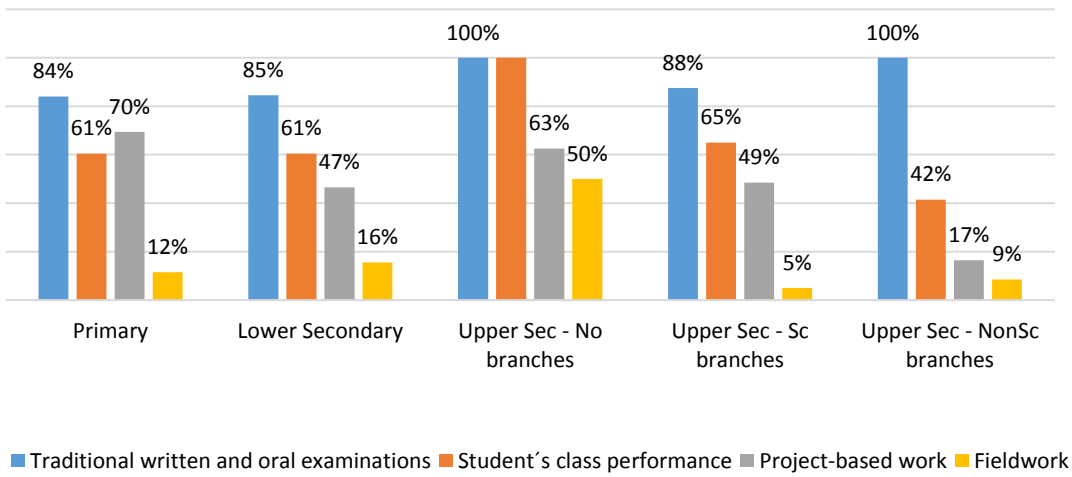
Graphic 50. Expert´s opinion on other type of actions implemented for teacher training in Natural Sciences, in countries that include Earth Sciences in their national National Science curriculum or standars (Average for all education levels)



Graphic 51. Expert´s opinion on main methods of student´s assessment in the Natural Sciences, in countries that include Earth Sciences in their national Natural Science curriculum or standards.



Graphic 52. Expert´s opinion on the main methods used for student´s assessment in the Natural Science at the global level, in countries that include Earth Sciences in ther national Natural Science curricula or satandards



ica and the Caribbean, they seem to indicate a path that is worth exploring. This is mainly because they do not necessarily depend on broader strategies, policies and actions coordinated at national level, but they are methods that can be utilized at local level that can be implemented in the short and medium term.

Graphic 53. Expert´s opinion on the inclusion of specific questions about Earth Sciences in standardized procedures for student's assessment, in countries that have standardized procedures at the national or international level and that include Earth Sciences

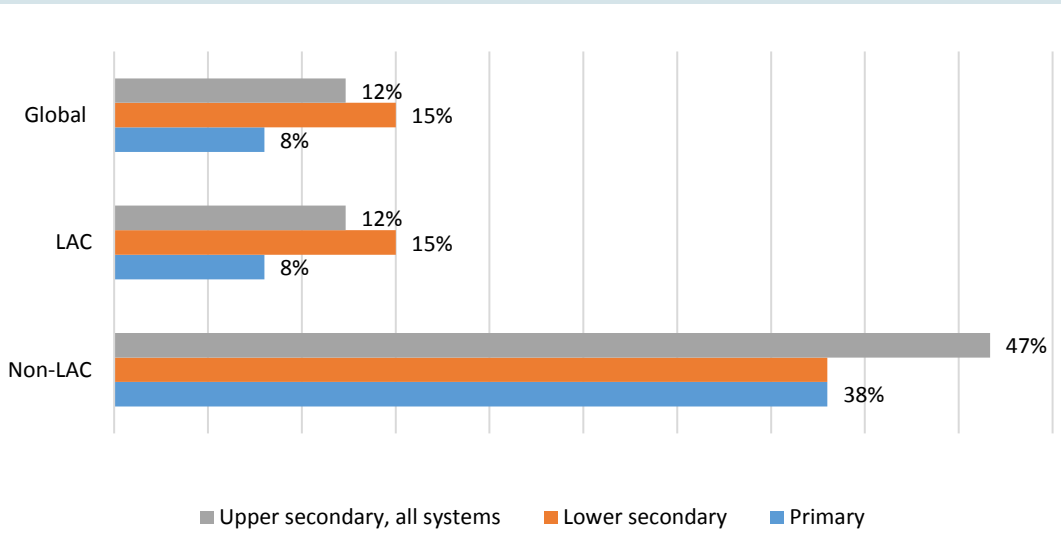


Table 54. Percentage of countries giving research encouragement and career information on Earth Sciences to students who choose Natural Science branches in upper-secondary education, in countries that have a multiple branching system in upper secondary education

	% of countries in which students receive encouragement/guidance to investigate issues in Earth Sciences			% of countries in which information about Earth Sciences-related careers is intentionally included in instruction		
	LAC	Non-Lac	Global	LAC	Non-Lac	Global
None	17%	4%	8%	25%	25%	25%
Very little	50%	50%	50%	50%	50%	50%
Some	25%	33%	31%	17%	25%	22%
A lot	8%	13%	11%	8%	0%	3%
Samples: LAC= 12, Non-LAC = 24.						

Geosciences learning evaluation

Concerning the evaluation of learning in Earth Sciences, the survey provided clues to strategies that can be applied soon. The experts believe that, in general, learning in Natural Sciences is still evaluated mainly through tools such as traditional oral and written examinations and student's participation. Except for the primary education level (where project-based work is relatively important), this trend is observed worldwide with similar levels across the different levels of education. Since this is valid for countries where there is a curriculum or national standards in Natural Sciences that include Earth Science content, it can infer that these are also the most common ways for the evaluation of Geoscience taught in class. Thus, the learning of Earth Sciences is evaluated in the same way as Natural Sciences in general. On the other hand, experts indicate differences both between countries and education levels on the inclusion of specific questions on Earth Sciences in the standardized evaluation procedures, either nationally or internationally (see Graphic 53).

In the case of upper secondary education, these results are seeming linked to the incentive that students receive to investigate Geoscience topics. In this regard, experts said that in half of the country's students choosing Natural Sciences branches receive "very little" encouragement or guidance to investigate topics related to Geosciences (see Table 54). In addition, experts indicated that some of them also receive "very little" information about tertiary careers in this area. According to their opinion, only 31% of the countries provide "some" support or guidance to students and 22% provide "some" information on the different university options in Geosciences.

These results can be used for opening the discussion on the most appropriate ways to evaluate student learning in Geosciences and what kind of materials or additional tools can be offered to teachers and schools to facilitate and improve such evaluation procedures. Of course, this discussion must be linked both to the content and learning objectives in Earth Sciences proposed by the curricula, as well as to the training of teachers who teach such content, through either formal or additional supports and actions.

Innovative institutional experiences and transformative pedagogies

Finally, but not least, experts gave their opinions on innovative institutional experiences and transformative pedagogies, both inside and outside the classroom. In this regard, 40% of Latin American and Caribbean experts and 66% of experts from other regions reported that innovations in Earth Science teaching (at primary/ lower secondary/ upper secondary level) have taken place in their countries in the past 10 years. In both cases, experts also reported there been cases where Earth Sciences

educators promoted or influenced social change in their respective communities -73% in Latin America and the Caribbean and 62% in other countries-.

In most cases, the experts also indicated that there are research groups focusing on Earth Science teaching (see Table 55). However, when analyzing opinions regarding the innovations made during the last 10 years in those countries where there are research groups, the result is striking. Unlike countries outside the region, innovation in Latin America and the Caribbean is at a very low level. In other words, countries are failing in transmitting research results to innovations, or innovators, outside and inside the classrooms. Thus, it is necessary to improve the dialogue between the research groups and teachers and decision makers on issues related to the teaching of Earth Sciences.

Table 55. Expert´s opinion on research and innovation on Earth Sciences teaching, in countries that include Earth Sciences in their national Natural Science curriculum or standards.

	% of countries in which students receive encouragement/guidance to investigate issues in Earth Sciences			% of countries in which information about Earth Sciences-related careers is intentionally included in instruction		
	LAC	Non-Lac	Global	LAC	Non-Lac	Global
1. Primary	67%	70%	50%	92%	25%	25%
2. Lower secondary	64%	71%	44%	80%	50%	50%
3. Upper secondary, all systems	75%	85%	19%	79%	25%	22%

* Samples: 1.LAC 13 countries, non-LAC 20 countries; 2. LAC 15 countries, non-LAC 21 countries; 3. LAC 11 countries, non-LAC 20 countries. ** Samples: 1.LAC 11 countries, non-LAC 14 countries; 2. LAC 9 countries, non-LAC 15 countries; 3. LAC 9 countries, non-LAC 17 countries

Opportunities for decision making in LAC

©José Selles

Dra. Beatriz MACEDO
Asesor Senior en Educación,
Ex Especialista de Programa,
División de Investigación y Prospectiva en Educación, UNESCO

Los análisis realizados de las encuestas tanto para los países de América Latina y el Caribe participantes como para los del resto del mundo son claros y explícitos en cuanto a la opinión que tienen los expertos acerca de cada uno de los ítems que contiene el instrumento.

Como aspecto positivo se debe ratificar lo que se adelantara en las primeras lecturas de la primera parte, la existencia de una voluntad política que se explicita en las agendas públicas de los países de la región en la promoción de la igualdad de género y empoderamiento de las mujeres y niñas en todos los niveles.

Esta información puede explicar el aumento de la población femenina en las carreras universitarias y/o superiores afines a las Ciencias de la Tierra (de ahora en más CT). Esta situación si bien se observa una evolución regional es muy heterogénea en las distintas subregiones de la región

Sin embargo, este hecho podría ser contradictorio con otras informaciones que indicarían que las metodologías y las maneras de evaluar siguen siendo tradicionales, por lo tanto, motivarían poco a los niños y niñas de los niveles inferiores del sistema educativo y no contribuiría a despertar el gusto y el interés por las Ciencias. Esta situación no es favorable para despertar el interés por carreras científicas.

Tanto en América Latina como en otras partes del mundo, se aprecia que las Ciencias Naturales forman parte de los currículos oficiales, en mayor o menor grado, sin embargo, es difícil afirmar que ello asegure el tratamiento de las CT en los ambientes intencionales de aprendizajes, es decir el aula. Más aún, cuando hay países que sitúan a las CT y sus contenidos de manera muy fragmentada en distintas disciplinas. Esto sucede en la región y fuera de ella.

Esta situación podría ser preocupante, pues se observa una fragmentación del corazón estructurante de las CT, que no solo le hace perder identidad, como ya se ha dicho, sino que da pie a que esos contenidos atomizados sean abordados de muy distintas maneras, pudiéndose dar el caso de no ser tratados como un conocimiento científico en sí mismo.

En el resto del mundo ya se menciona como una preocupación el hecho que en la mayoría de los países la evaluación continúa basada en escritos tradicionales y orales y que solo en una minoría de países se trabaja con metodologías de proyectos. En la región la situación no difiere demasiado, ya que un 88 % de las respuestas mencionan esta misma situación.

Si, por un lado, se tiene unas CT desagregada en distintas "subdisciplinas" o asignaturas del currículo de primaria y de secundaria, y por otro las respuestas permiten observar que las metodologías y las formas de evaluar no tienden a un aprendizaje pertinente y eficaz, se puede suponer que la mayoría de los alumnos no van a egresar de la educación obligatoria con la formación que les permita actuar como ciudadanos/as informados y competentes para tomar decisiones.

Estas afirmaciones se refuerzan con las respuestas que expresan que, en la mayoría de los casos en la región, la enseñanza se basa en el conocimiento de hechos y principios -40% para primaria-, mientras que solo otro 40% afirma poner algún énfasis en la aplicación de la ciencia a contextos de la vida real. Esta situación no varía prácticamente si se analizan las informaciones para el nivel secundario.

Esto es ya de por sí, un llamado de atención, hay que leerlo sabiendo que se contesta para las Ciencias Naturales, dentro de las cuales las CT tienen una presencia cambiante y desigual.

Llama la atención que para la región se encuentre que un 66 % de los docentes actuantes en primaria, tienen un perfil de ciencias básico general, mientras que en las lecturas de los informes parecería surgir de que los docentes de este nivel no tenían una formación específica en ciencias.

Se debería entender que un perfil de ciencias básico de nivel general significa una formación no especializada

en ciencias y que solamente poseen los conocimientos básicos que brinda la formación de docentes de primaria.

En el nivel secundario, en general, son profesores de ciencias básicas y además hay otros especialistas como biólogos en Geografía, Química o Física. Esta situación no es muy diferente a la que se observa en el resto del mundo.

Estas indicaciones son coherentes con las respuestas a nivel regional, que las mayores innovaciones se realizan a nivel de proyectos individuales a nivel institucional. Estas respuestas las podemos entender como que las innovaciones, los trabajos y abordajes de ciertas temáticas se dan a nivel de centro educativo, más allá de las políticas nacionales. Parecería que los docentes y las escuelas comprenden las necesidades de formación de sus estudiantes y buscan nuevas maneras de enseñar y nuevos contenidos a enseñar, por considerarlos relevantes para el accionar de cada persona en la vida cotidiana. Algunos países de la región mencionan la intencionalidad de las políticas nacionales de poner en conocimiento de los alumnos desde las edades más tempranas con determinadas especialidades de las CT.

En este mismo sentido se debe mencionar que una mayoría de países de la región (73.33%) mencionan que hay en marcha o en elaboración reformas curriculares que llevarían a un cambio de esta situación. En este punto parece necesario recordar que las reformas curriculares, por sí mismas, no permiten asegurar la inclusión y el tratamiento adecuado de ciertas temáticas en las aulas.

Una diferencia importante entre América Latina y el Caribe y el resto del mundo es la existencia o no de pruebas estandarizadas que contemplen las CT. Hay muchos países de la región que aplican pruebas nacionales, donde estas temáticas no están contempladas o están muy simplificadas y su presencia es muy escasa.

Este hecho se puede interpretar, que en esas pruebas nacionales se evalúan aquellos aprendizajes que todas las niñas y todos los niños deben lograr en un determinado momento de su escolaridad. El no contemplar las temáticas de las CT, podría encerrar un mensaje implícito dando a entender que estos aprendizajes no son importantes o necesarios para todos y cada uno de los alumnos. *¿Las Ciencias de las Tierra contribuyen como ingrediente indispensable de la formación ciudadana o no?* Si la respuesta es *Si*, sus contenidos deberían ser evaluados al mismo nivel jerárquico que otros contenidos que se ven priorizados en estas pruebas.

Es este uno de los aspectos, no de forma exclusiva, donde se pueden ver las rupturas existentes, entre los propósitos explícitos en las políticas y/ o agendas públicas y lo que verdaderamente se piensa, se hace y se concreta a nivel escolar. Cada vez más la escuela, en sentido amplio, tiene que asegurar a toda la formación ciudadana y ayudar a que cada uno pueda formar un proyecto de vida.

El panorama expresado tanto en los análisis de la parte I como en la parte II nos permitiría observar que aún estamos lejos de incorporar a las CT en una *ciencia para la vida y en la vida*, a través de la cual se forman ciudadanas y ciudadanos capaces de actuar responsablemente en la vida democrática y en la construcción de un mundo mejor para todos.

Hay fortaleza que es importante destacar, ya que, a partir de ellas, se deben basar las líneas de proyectos regionales que permitan situar a las CT de las Ciencias Naturales, con una identidad propia, lo que significa objetos de aprendizaje y enseñanza que le son propios, maneras de desarrollar el conocimiento y abordarlo también específicos. No es el deseo, querer aislar a las CT de las otras Ciencias, muy por el contrario, se trata de encontrar los puentes y las interfases de trabajos inter y multidisciplinarios, pero sin que ello signifique perder de vista lo que le es propio.

Se debería intensificar el trabajo para que las agendas públicas tomen la temática con verdadera convicción y esto se refleje en las políticas educativas de los distintos países. No se trata de reivindicar la presencia de estas áreas del saber por la reivindicación en sí misma, o para hacer más de lo mismo, se plantea una resignificación de lo que deberían ser las Geociencias a nivel escolar y secundario, con una propuesta de calidad, que implica sentido y pertinencia de los aprendizajes que se busca lograr.

De la misma manera se trataría de buscar nuevas formas de enseñar y de evaluar para que los aprendizajes sean logrados. El momento es propicio, pues muchos países destacan que están en procesos de cambios pedagógicos y curriculares, por lo cual los canales estarían abiertos a nuevas miradas y concepciones.

Es de destacar también, con mucho énfasis, la mayor participación de las niñas y mujeres en estas temáticas, lo que debe seguir en un camino de evolución que brinde iguales oportunidades a todos. Si las maneras de enseñar y de evaluar están en procesos de cambio, poniendo el foco en lo que los estudiantes aprenden, esto

hará que los estudiantes se sientan actores de su propio aprendizaje y redescubran el placer por aprender y por aprender Ciencias de la Tierra en particular.

Parecería que el momento es adecuado para superar algunas rutinas pedagógicas que no han permitido a los estudiantes descubrir la aventura que significa abordar el conocimiento científico. Una aventura que no está exenta de dudas, de idas y venidas, de indagación, búsqueda e investigación, de argumentaciones, de errores que permiten seguir avanzando en la aventura, en la cual hay pocas certezas y muchas incertidumbres. Una estudiante o un estudiante a quien se le permite abordar el conocimiento científico como una aventura hacia un saber seguramente sentirá la pasión y la alegría de aprender y seguir aprendiendo.

El error es parte del avance del conocimiento, y no es el error de un estudiante para ponerlo en evidencia y mostrar que no ha aprendido. El error debe ser tomado como parte del aprendizaje. Esta mención está unida a la necesidad, que durante la escolaridad obligatoria esa muchacha o muchacho debe ir elaborando su proyecto de vida, lo que significa encontrar vocaciones y hacer opciones. No podrá optar por algo que no conoce, por lo tanto, es importante hacer conocer y despertar el interés por todo lo que encierran las Ciencias de la Tierra.

Más aún si las informaciones recabadas muestran que hay cada vez más ofertas de formaciones terciarias y/o universitarias relacionadas con las Ciencias de la Tierra y que además se constata una falta de profesionales formados para cubrir estas áreas, en el mercado laboral.

Algunos puntos que destacar

Después de mencionar lo anterior se acentúan los siguientes puntos:

- Es necesario que se trabaje en los países para que las Ciencias de la Tierra encuentren su identidad curricular, y sean reconocidas como tales. esto significa superar la situación actual, ya que, en muchos casos, se les considera apéndices de otras ciencias.
- El hecho que en los distintos países las Ciencias de la Tierra, se ubiquen en el interior de otras disciplinas, no parece menor. Podría significar que no se les asigna como un objeto o campo propio de estudio, por lo tanto, se entiende que forman parte, según sus temas, de unas u otras asignaturas de existencia ya asegurada, desde hace tiempo, en los currículos de primaria y secundaria.
- El mismo hecho tiene consecuencias que se entienden más profundas, parecería que su ubicación en una u otra asignatura o en varias a la vez, no tiene impactos en los sustentos y abordajes epistemológicos, pedagógicos y didácticos. Sin embargo, se debe entender que estos impactos se traducen en distintas maneras de abordar el conocimiento y en especial, en cómo se interpreta el aprendizaje de estos y por la tanto su enseñanza y su evaluación. Con esto se quiere significar que no se enseñará de la misma manera si lo aborda un profesor de Geografía, de Educación Ambiental, de Física o de Química, solo por mencionar algunas de las varias posibilidades
- Las Ciencias de la Tierra al tener objetos de aprendizaje, de enseñanza y de evaluación propios requiere que se desarrolle la investigación en didáctica de las Ciencias de la Tierra. Ello conlleva a concebir un campo propio de construcción de conocimiento, lo que no significa, como ya se ha dicho que en esta producción no se recurra a otras ciencias y campos del saber-
- Hay que prestar especial atención, no solamente, a su inclusión en los currículos de primaria y de secundaria, sino, además, a la formación de educadores que debe asegurar el real tratamiento de estas en el aula. Esto significa formaciones adecuadas y pertinentes de maestros y profesores.
- Los materiales de apoyo a la enseñanza deben adaptarse a estas nuevas miradas, y abandonar el enunciado de hecho y listados de contenidos, que nada tienen que ver con las nuevas estrategias y dispositivos de enseñanza.
- Cabe destacar la importante iniciativa de la UNESCO, que nos permite conocer el estado de situación a partir del cual se pueda continuar construyendo colectivamente, para la superación de algunas de estas debilidades.

Pistas para seguir avanzando

Este trabajo que acerca la UNESCO, es importante para los expertos en Ciencias de la Tierra, pero en especial es un insumo de gran interés para los tomadores de decisión en materia educativa de los distintos países de la región.

Los países de la región se enfrentan a problemas educativos de importante índole, solo por nombrar algunos, cada vez menos interés en los campos del saber científico, poca inserción de las mujeres en estas áreas, abandono frecuente de estudiantes de la secundaria, pues no logran construir subjetividad ni, por lo tanto, elaborar proyectos de vida.

Es necesario destacar que hablar de América Latina y el Caribe, es hablar de un mosaico de heterogeneidades, donde toda generalización pierde validez. Es por ello por lo que la frase anterior no se adecua a la realidad de todos los países y es imposible que todos se vean reflejados en esta apretada síntesis.

Sin embargo, si se comparte que la educación obligatoria debe contribuir a la formación de ciudadanos capaces de insertarse en la sociedad de manera eficaz y feliz, se deberían abrir las puertas a trabajos regionales para que esto suceda, por lo que de ahí surgen las siguientes preguntas:

- ¿Cómo puede la educación hacer esta contribución a estos adolescentes y jóvenes, si cada vez más sienten que lo que se les enseña no tiene ningún sentido para ellos?
- ¿Cómo recobrar que los aprendizajes tengan sentido y pertinencia?

Esta última pregunta es compleja, pues tiene varias vertientes de respuestas. Que no deben ni pueden ser abordadas con respuestas fáciles, que omiten el escenario incierto en el cual la educación se mueve.

Sin embargo se puede decir, que es imperioso una revisión de los aprendizajes que se buscan lograr; las maneras como se pretenden promover esos aprendizajes; las maneras de evaluar; los climas instalados en las instituciones educativas; las relaciones que se imponen en los centros educativos entre docentes; estudiantes y objetos de aprendizaje y de enseñanza; la formación, dedicación y condiciones de trabajo de los educadores en estos niveles educativos; la escasa producción de conocimiento que existe en muchos países, de la significación del propio hecho educativo; entre otras muchos más aspectos que se podrían mencionar. Este documento nos abre ventanas, que podrían dar alguna respuesta a la pregunta planteada más arriba.

Otras investigaciones muestran como los niños y niñas desde las edades escolares, se interesan por la Tierra en la cual habitan, hay por un lado algo de misterio que los atrae y por otro la necesidad de entender los motivos por los cuales suceden determinadas cosas. Casi ningún país de la región escapa hoy a desastres naturales, unos de mayor magnitud, otros de menor, pero en todos los casos existen y en principio siempre perjudican a las poblaciones más desprotegidas.

Parece importante que contenidos de las Ciencias de la Tierra puedan ser introducidos desde la escuela primaria y continuar en secundaria, para formar a esos futuros ciudadanos, a través de hechos a los cuales se enfrentan a diario en su vida cotidiana. El estudio nos dice, con contundencia, que las Ciencias de la Tierra, se fragmentan en varias asignaturas, no siempre forman parte ni siquiera del currículo prescripto, ni hablar del currículo enseñando, no parecería que forman parte del núcleo de los conocimientos y aprendizajes que todo ciudadano debe manejar para moverse de manera competente en la vida cotidiana.

Por lo tanto, no parece una buena decisión que este documento sea que empiece y termine en sí mismo, presenta un muy buen estado de situación. Parecería que invita a tomar ciertas iniciativas, si se quiere que contribuir a que niños y jóvenes sean personas bien comprometidas con el bien colectivo y con la construcción de un mundo más justo y equitativo para todos.

En ese sentido y una vez bien analizado el escrito que se presenta se piensa que:

- Los expertos y los tomadores de decisión en los currículos y en la formación de educadores de la región deberían formar una interfase de trabajo con el fin de determinar, cuáles son los contenidos estructurantes en Ciencias de la Tierra, que partiendo desde el nivel primaria y siguiendo toda la escolaridad obligatoria, promoverán la formación que nuestros jóvenes requieren,
- Estas interfases de trabajo deberían ser a nivel nacional para luego integrar la regional donde se intercambien avances e ideas.
- Los expertos deben pensar que no se pretende formar especialistas en Ciencias de la Tierra, sino ciudadanos bien formados e informados, también es cierto que de esta manera se logrará despertar el interés por estas áreas y poder contar en los países de la región con más y mejores profesionales que actúen en Ciencias de la Tierra y sus actividades anexas.

- Parecería importante que estas interfases logren proponer progresiones de aprendizaje, coherentes, y bien situadas en los currículos escolares.
- Ello significaría poder construir colectivamente unas Ciencias de la Tierra escolar, para despertar el interés de todas y todos los estudiantes, lograr buenas formaciones y motivar por carreras terciarias y/o universitarias afines.
- Elaborar materiales de apoyo a la promoción y aprendizaje en la educación obligatoria, donde los expertos deben tener un papel protagónico, aunque no serían los únicos que deban trabajar en ellos, ya que no se debe perder de vista que esos contenidos deben ser reinterpretados para que puedan ser aprendidos y enseñados
- Los expertos podrían crear una red regional de apoyo a la educación en Ciencia de la Tierra, con interacciones con tomadores de decisión, formadores y educadores, para lograr que los conocimientos a tratar puedan efectivamente ser tratados.
- Por todo lo expuesto con anterioridad, se propone abrir una instancia de diálogo e intercambios, con el fin de elaborar de manera conjunta un proyecto regional que permita superar las situaciones que se han descripto en este documento. Este proyecto regional requiere del compromiso de los expertos y la disposición, por ambas partes, expertos y académicos y actores provenientes de la educación para una buena propuesta.
- El documento que se presenta, pone en evidencia que desde la educación no se ha podido dar respuestas a los requerimientos de una formación adecuada en Ciencias de la Tierra, que hay poca "expertos", por lo tanto se insiste que estos campos del saber se pongan a disposición de la formación de una ciudadana y de un ciudadano que pueda vivir, desarrollarse como ser y como ser social, comprendiendo los fenómenos que lo rodean y sabiendo cómo deben ser sus actitudes y compromisos para garantizar un mundo mejor.
- El documento debería ser debatido ampliamente, involucrando a los tomadores de decisión en políticas educativas de manera regional y por país.

Appendix

Cuestionario utilizado en el relevamiento

La encuesta de opinión a expertos se publicó en la plataforma SurveyMonkey y estuvo disponible de mayo a noviembre de 2017. Los expertos invitados podían acceder al mismo a través de los enlaces personalizados enviados por correo electrónico. El cuestionario definitivo constó de un máximo de 140 preguntas divididas en las siguientes secciones:

1. Datos del encuestado
2. Sección 1: Perfil del país
    a. Prioridades generales de desarrollo y tendencias del mercado de trabajo vinculado a las Geociencias
    b. Características de las políticas de educación científica
3. Educación primaria
    a. Currículo de Ciencias Naturales
    b. Contenidos de Ciencias de la Tierra
    c. Mecanismos de evaluación del aprendizaje
    d. Formación docente y materiales de enseñanza
4. Educación secundaria baja
    a. Currículo de Ciencias Naturales
    b. Contenidos de Ciencias de la Tierra
    c. Mecanismos de evaluación del aprendizaje
    d. Formación docente y materiales de enseñanza
5. Educación secundaria alta
    a. Currículo de Ciencias Naturales
    b. Contenidos de Ciencias de la Tierra
    c. Mecanismos de evaluación del aprendizaje
    d. Formación docente y materiales de enseñanza
6. Aprendizaje informal y actividades extracurriculares
    a. Características y actores principales
    b. Eventos nacionales
7. Innovaciones educativas y sociales
    a. Descripción de prácticas exitosas

El cuestionario se basó en la Clasificación Internacional Normalizada de la Educación, los Campos de Educación y Capacitación (ISCED-F 2013) elaborada por la UNESCO para facilitar la comparación de las estadísticas e indicadores de la educación entre países sobre la base de definiciones uniformes y acordadas internacionalmente. Los campos detallados que se muestran en la herramienta de búsqueda de la CINE se destinan principalmente a ser utilizados en el nivel terciario de la educación y en los programas de educación y formación profesional y las cualificaciones de los niveles secundario y post secundario no terciario. La CINE permite reunir, compilar y presentar estadísticas de educación de manera uniforme. Ciencias Naturales.

De acuerdo a la Clasificación Internacional Normalizada de Educación, los campos de Educación y Capacitación (CINE-F 2013) relacionados con "Ciencias Naturales, Matemáticas y Estadísticas" (código 05) son los siguientes: Ciencias biológicas y afines (051), incluidas Biología (0511), Bioquímica (0512); Medio ambiente (052), incluidas las Ciencias del medio ambiente (0521) y Medio ambientes naturales y vida silvestre (0522); Ciencias físicas (053), incluidas Química (0531), Ciencias de la Tierra (0532), Física (0533); y Matemáticas y estadística (054), incluidas Matemáticas (0541) y Estadística (0542). En el formulario se consideró que las Ciencias Naturales están integradas por: Biología y Ciencias afines (051), Ciencias Ambientales (052) y Ciencias Físicas (053), y sus respectivas ciencias relacionadas anteriormente.

Por otro lado, de acuerdo con la Clasificación Internacional Normalizada de Educación, las Ciencias de la Tierra refieren al estudio de la composición y estructura de la tierra, incluyendo la hidrosfera y la atmósfera. Los campos de Educación y Formación (CINE-F 2013) relacionados con "Ciencias de la Tierra" (código 0532) son los siguientes: Ciencias atmosféricas, In-

vestigación climática, Ciencias de la Tierra, Geodesia, Sistemas de información geográfica (SIG), Geografía (natural), Geografía (física), Geo informática, Geología, Geomática, Geofísica, Geociencias, Tecnología geoespacial, Hidrogeología, Hidrología, Ciencias Marinas, Meteorología, Mineralogía, Ciencias de la vida marina, Oceanografía, Paleontología, Sismología, Vulcanología.

El cuestionario se encuentra a disposición de los interesados, que deberán solicitarlo al Programa Internacional de Geociencias y Geoparques de la UNESCO para América Latina y el Caribe, UNESCO Montevideo.

Participating experts by country

1. ARGENTINA

   Mr. José SELLES-MARTÍNEZ, Prof. Dr.
   Department of Geological Sciences
   Departamento de Ciencias Geológicas
   School of Natural Sciences
   University of Buenos Aires
   pepe@gl.fcen.uba.ar
   http://www.gl.fcen.uba.ar/
   * Miembro del Consejo de IGEO

   Contributors: Prof. Dr. (c) Diego ARIAS (Research Group in Interdisciplinary Didactics of the Natural Sciences, Training and Research Center in Teaching of Sciences - CEFIEC, Faculty of Exact and Natural Sciences, University of Buenos Aires); Lic. Marcelo BAZÁN (Provincial Directorate of Secondary Education, General Directorate of Culture and Education, Government of the Province of Buenos Aires): Prof. Dr. Leonor BONAN (Research Group in Interdisciplinary Didactics of Natural Sciences, Training and Research Center in Teaching of the -CEFIEC, Faculty of Exact and Natural Sciences, University of Buenos Aires); Dr. Vera BRUDNY (Responsible, Program "Latin American Center for Interdisciplinary Training", National Ministry of Science, Technology and Productive Innovation, Presidency of the Nation); Prof. Marta BULWIK (General Directorate of Higher Education, Ministry of Education, Autonomous City of Buenos Aires); Prof. Dr. Alberto CASELLI (Director, Laboratory of Study and Monitoring of Active Volcanoes - LESVA, Institute of Research in Paleobiology and Geology - IIPG, National University of Rio Negro); Prof. Esteban DICOVSKIY (Escuela Normal Superior No. 10 - CABA, National Institute of Teacher Training, Ministry of Education and Sports, Presidency of the Nation); Prof. Emeritus Dr. Héctor Luis LACREU (Department of Geology, Faculty of Physical and Mathematical Sciences, National University of San Luis); Prof. Dr. (c) María Julia SOLARI (Chair of Micro Soil Morphology, Faculty of Natural Sciences and Museum, National University of La Plata); Mag. Javier José SIMON (National Institute of Teacher Training, Ministry of Education and Sports, Presidency of the Nation); Mag. Graciela del Rosario SOSA (Department of Geology, Faculty of Physical and Mathematical Sciences, National University of San Luis).

2. AUSTRALIA

   Ms. Bronte NICHOLLS, Dr.
   Director
   Pedagogical Innovation
   Australian Science and Mathematics School
   slab@internode.on.net
   * Member of IGEO

3. GERMANY

   Mr. Dirk FELZMANN, Prof. Dr.
   Professor
   Unit Geography Teaching
   Institute of Natural Sciences
   University of Koblenz-Landau, Campus Landau
   felzmann@uni-landau.de
   * Member of IGEO

4. BULGARIY

   Ms. Stefka DIMITROVA PRISTAVOVA, Prof. Dr.
   Vice Rector for International Cooperation and Projects
   University of Mining and Geology "St. Ivan Rilski"
   stprist@mgu.bg
   * Member of IUGS-COGE

5. BOLIVIA

Mr. Nelson FERRUFINO, Prof. Dr.
Center for the Improvement of Mathematics and Computer Education (MEMI)
School of Science and Technology
University of San Simon
nelson.f@memi.umss.edu.bo

Contributors: Prof. Mag. Cecilia CASTRO (Physics and Didactics of Physics, Department of Physics, Faculty of Sciences and Technology, Universidad Mayor de San Simón); Prof. Mag. Amilcar MARTINEZ (Department of Mathematics, Faculty of Sciences and Technology, Universidad Mayor de San Simón); Prof. Dr. (c) Fernando LEDEZMA (Area of Water Resources and Water Quality, Department of Civil Engineering, Faculty of Sciences and Technology, Universidad Mayor de San Simón); Lic. Biol. Rosa MENESES (Botany Unit, National Herbarium of Bolivia, Universidad Mayor de San Andrés); Prof. Mag. Dayné AGREDA (School "San Martín de Porres", Departmental Directorate of Education - Cochabamba / Quillacollo); Mtra Tania MERCADO (Instituto America Vecinal "C", Departmental Department of Education - Cochabamba / Cochabamba); Mtra Delia GONZALEZ (Instituto America Vecinal "C", Departmental Directorate of Education - Cochabamba / Cochabamba).

6. BRASIL

Mr. Nelson Luiz SAMBAQUI GRUBER, Prof. Dr.
Vice Director
Department of Geography
Institute of Geoscience
Federal University of Rio Grande do Sul
nelson.gruber@ufrgs.br

Contributors: Prof. Dr. Rualdo MENEGAT (Jefe, Departamento de Paleontología e Estratigrafía, Instituto de Geociencias – IGEO, Universidad Federal de Rio Grande do Sul-UFRGS), Prof. Dr. Cláudia Luísa ZEFERINO PIRES (Departamento de Geografia, Instituto de Geociencias – IGEO, Universidad Federal de Rio Grande do Sul-UFRGS).

7. CANADA

Ms. Lesley HYMERS, M.Sc.
Manager
Education and Outreach Programs
Minning Matters
lhymers@miningmatters.ca
* Member of IGEO

8. CHILE

Ms. María Eugenia CISTERNAS, Prof. Dr.
Institute of Economic Applied Geology
University of Concepción
mcistern@udec.cl

Contributors: Prof. Dr. Martín JACQUES COOPER (Department of Geophysics Faculty of Physical Sciences and Mathematics, University of Concepción).

9. CHINA

Mr. Yanxiu SHAO, Dr.
Lanzhou Institute of Seismology
China Earthquake Administration
shaoyx@geoidea.org
* Member of IGEO

10. COLOMBIA

Mr. Alfonso Claret ZAMBRANO, Prof. Dr.
Department of Natural Science Education
Institute of Education and Pedagogy
Universidad del Valle
alfonso.zambrano@correounivalle.edu.co

Contributors: Carlos Vargas, Associate Professor, Department of Geo-sciences, National University of Colombia; Carme HUGUET, Assistant Professor, Department of Geo-sciences, Universidad de los Andes; Clara PARDO MARTÍNEZ, Dra., Professor, Universidad del Rosario; Felipe LAMUS OCHOA, Mg., Professor, Fundación Universidad Del Norte; Johanna MENDEZ-DUQUE, National Program of Science, Technology and Innovation in Geosciences - Colciencias, Corporación Geológica

Ares; Tatiana ESPINOSA, Area of Education in Natural Sciences, Institute of Education and Pedagogy, Universidad del Valle; Carlos Alberto Ríos Reyes, Industrial University of Santander; Jorge RUBIANO, Professor, Department of Geography, Universidad del Valle; Luz Adriana RENGIFO GALLEGO, Professor Universidad del Cauca; Miguel Antonio Espinosa Rico, Professor University of Tolima; Iván PÁEZ GUTIÉRREZ, Mg. Administrative Department of Science, Technology and Innovation - COLCIENCIAS; Gloria PRIETO RINCÓN, Dra. Colombian Geological Service.

11. SOUTH KOREA

Ms. Young-Shin PARK, Prof. Dr.
Department of Earth Science Education
Collgege of Education
Chosun University
parkys@chosun.ac.kr
* Member of IGEO

12. COSTA RICA

Ms. Adriana ZÚÑIGA MELÉNDEZ, Prof. Dr.
Deputy Director
School of Biological Sciences
National University of Costa Rica
adriana.zuniga.melendez@una.cr

Contributors: Prof. Dr. Gustavo BARRANTES CASTILLO (assistant director, School of Geographical Sciences, National University of Costa Rica); Prof. Mag. Isabel TORRES SALAS (Division of Education, Research Center and Teaching in Research, National University of Costa Rica).

13. CUBA

Mr. Pedro ALVAREZ CRUZ, Prof. Dr.
Department of Natural Sciences
Faculty of Education in Natural Sciences
University of Pedagogig Sciences "Enrique José Varona"
pealcruz@gmail.com

14. DENMARK

Ms. Rie Hjørnegaard MALM, Doctoral Research Fellow
Section of Geology and Geophysics
Department of Geosciences
Faculty of Mathematics and Natural Sciences
University of Copenhagen
r.h.malm@geo.uio.no
* Member of IGEO

15. ECUADOR

Ms. Paulina Morales H., Prof. Dr.
Dean
Facultad de Ciencias de la Educación
Pontifical Catholic University of Ecuador
Pmorales048@puce.edu.ec

Contributors: Prof. Mg. Carlos CORRALES GAITERO (Faculty of Educational Sciences, Pontifical Catholic University of Ecuador - PUCE), Prof. Mg. Mercy VACA CASTRO (Faculty of Education Sciences, Pontificia Universidad Católica del Ecuador - PUCE).

16. EGYPT

Ms. Kholoud ABDELMAKSOUD, Prof. Dr.
Natural Resources Department
Institute of African Research and Studies
Cairo University
kholoud.mohamedali@gmail.com
* Member of IGEO

17. EL SALVADOR

Ms. Catalina MACHUCA DE MERINO, Mtra. MA.
Academic Vicerrector
Pedagogical University "Dr. Luis Alonso Aparicio"
cmerino@pedagogica.edu.sv

18. UNITED STATES ESTADOS UNIDOS

Mr. Steven ANDERSON, Prof. Dr.
Earth and Atmospheric Sciences Program
College of Natural and Health Sciences
University of Northern Colorado
steven.anderson@unco.edu
*Member of IGEO

19. SPAIN

Ms. Amelia CALONGE, Prof. Dr.
Dean
Faculty of Education
University of Alcala
a.calonge@uah.es
*Member of IGEO

20. FILIPINAS

Mr. Miguel C. Cano, Prof. MA.
Graduate School
Bicol University
jurassic.mike@yahoo.com
* Member of IGEO

21. FINLANDIA

Ms. Mia KOTILAINEN, Prof. Dr.
Education Coordinator
Department of Geosciences and Geography
University of Helsinki
mia.kotilainen@helsinki.fi
*Member of IGEO

22. FRANCE

Ms. Florence LE HEBEL, Prof. Dr.
Laboratorio ICAR (Interacciones, Corpus, Aprendizaje, Representaciones, UMR 5191)
Escuela Normal Superior
University Lyon II
florence.le-hebel@ens-lyon.fr
* Member of IGEO

23. GREECE

Ms. Georgia FERMELI, Dr.
Coordinator
Science, Technology, Engineering and Mathematics Unit
Institute of Educational Policy
Ministry of Education
f.georgia@gmail.com
* Member of IGEO

24. GUATEMALA

Mr. Leonel Roberto ARMAS ESTRADA , Dr.
UNESCO Office

Contributors: Miguel Ángel GUZMÁN, Lic. (Dirección General de Gestión de Calidad Educativa - DIGECADE, Ministerio de Educación); Sr. Erick Fernando RUEDAS R., MSc. (Dirección General de Currículo - DIGECUR, Ministerio de Educación), Sra. Marta Lizeth CUÉLLAR B., Lic. (Dirección General de Gestión de Calidad Educativa - DIGECADE, Ministerio de Educación); Sra. Georgina S. AFRE, Ing. (Dirección General de Evaluación e Investigación Educativa - DIGECADE, Ministerio de Educación); Sr. Salvador QUIACAIN, Lic. (Dirección General de Educación Bilingüe Intercultural - DIGEBI, Ministerio de Educación); Sr. Carlos AVENDAÑO, Lic. (Dirección General de Educación Extraescolar - DIGEEX, Ministerio de Educación); Sra. Silvia Edith ROSALES, MSc. (Directora del Área Científica - Facultad de Educación, Universidad del Valle); Sr. Manolo BARILLAS, Ing. (Asesor Nacional de Respuesta a Desastres, Oficina de la ONU para la Coordinación de Asuntos Humanitarios - OCHA).

25. GUYANA

Ms. Petal PUNALALL-JETOO
National Coordinator
Science Unit
National Center for Educational Resource Development
Ministry of Education
petaltp@yahoo.com

Contributors: Dr. Amanda KISSOON-RUSSELL (Senior Specialist in Matter, Social Studies, National Center for the Development of Educational Resources, Ministry of Education); Prof. M.Sc. Linda JOHNSON-BHOLA (Faculty of Earth and Environmental Sciences, University of Guyana); Prof. Emeritus Patrick WILLIAMS (Faculty of Earth and Environmental Sciences, University of Guyana).

26. INDIA

Mr. Ramanathan BASKAR, Prof. Dr.
Department of Environmental Sciences and Engineering
Guru Jambheshwar University of Science and Technology
rbaskargjuhisar@yahoo.com
*Member of IGEO

27. INDONESIA

Mr. Donatus Hendra AMIJAYA, Prof. Dr.
Department of Geological Engineering
Faculty of Engineering
Gadjah Mada University
hamijaya@gadjahmada.edu

28. IRÁN

Ms. Hanieh BAKHSHAEE, MA.
Senior Expert
Department of International Affairs
Geological Survey and Mineral Exploration of Iran
haniehbakhshaee@gmail.com
* Miembro de IGEO

29. ISRAEL

Mr. Nir ORION, Prof. Dr.
Head
Earth Science and Environment Group
Science Teaching Department
Weizmann Institute of Science
ntorion@wisemail.weizmann.ac.il
*Member of IGEO

30. ITALIA

Ms. Susanna OCCHIPINTI, Dr.
Director
Technical School "Innocent Manzetti-Aosta"
ITALIA
susocchip@gmail.com
*Member of IGEO

31. JAPÓN

Mr. Yoshisuke KUMANO, Prof. Dr.
Department of Science Education
Faculty of Education
Shizuoka University
kumano.yoshisuke@shizuoka.ac.jp
* Member of IGEO

32. KYRGYZSTAN

Mr. Buras BOLJIEV, Dr.
Institute of Theoretical and Applied Mathematics
Academy of sciences of the Kyrgyz Republic
Ministry of Education
boljievb@mail.ru

33. MALAWI

Mr. Zuze DULANYA, Prof. Dr.
Geography and Earth Sciences Department
Chancellor College
University of Malawi
zdulanya@cc.ac.mw
*Member of IGEO

34. MAURITIUS

Mr. Bhanooduth LALLJEE, Prof. Dr.
Department of Agriculture and Food Science
Faculty of Agriculture
University of Mauritius
vinodl@uom.ac.mu
*Member of IGEO

35. MEXICO

Ms. Diana Patricia RODRÍGUEZ PINEDA,
Prof. Dr.Head of the Academic Body of Science Education
Coordinator of the Doctorate in Education
National Pedagogical University
dpineda@upn.mx

Contributors: Dr. Fernando CARRETO-BERNAL (Leader of the Academic Body in Education and Teaching of Geography, Founder

of the Geographical Observatory of Latin America Faculty of Geography, Autonomous University of the State of Mexico, Toluca); Dr. Rafael Ernesto SÁNCHEZ SUÁREZ (Full Time Professor, Title A, National Preparatory School 5 José Vasconcelos, National Autonomous University of Mexico, Mexico City); Mtro. José Luis BLANCAS HERNÁNDEZ (Deputy Director of Natural Sciences, General Directorate of Educational Materials, Undersecretariat of Basic Education, Secretariat of Public Education, Mexico City).

36. MONGOLIA

Ms. Gerel OCHIR, Prof. Dr.
Director
Geoscience Center
School of Geology and Mining
Mongolian University of Science & Technology
gerel@must.edu.mn

37. NAMIBIA

Ms. Kombada MHOPJENI, MSc.
Deputy Director
Geological Survey of Namibia
Ministry of Mines and Energy
Kombada.Mhopjeni@mme.gov.na
*Member of IUGS/COGE

38. NICARAGUA

Mrs. Mélida SCHLIZ ANTEQUERA, Prof. Mag.
Academic secretary
Institute of Geology and Geophysics
National Autonomous University of Nicaragua
melida.schliz@igg.unan.edu.ni

39. NEW ZEALAND

Mr. Glen David VALLENDER, Dr.
Director
Educational Research and Science Resources Ltd
ge.vallender@xtra.co.nz
*Member of IGEO

40. NORWAY

Ms. Kari Beate REMMEN, Prof. Dr.
Department of Teacher Education and School Research
Faculty of Educational Sciences
University of Oslo
k.b.remmen@ils.uio.no
*Member of IGEO

41. PAKISTÁN

Mr. Waqas Khalid KHOKHER, MA.
Exploration Directorate
Oil & Gas Development Company Limited (OGDCL)
waqas.khalid@yahoo.com
*Member of IGEO

42. PERÚ

Ms. Themis Castellanos Del Portal
Research Coordinator
Educational Research and Services Center
Pontifical Catholic University of Peru
tcastellanos@pucp.pe

43. PORTUGAL

Ms. Clara VASCONCELOS, Dr.
Unit of Science Teaching
Department of Geosciences, Environment and Territorial Planning
Science Faculty
University of Porto
csvascon@fc.up.pt
* Member of IGEO

44. RUSIA

Mr. Evgeny NESTEROV, Prof. Dr.
Director
Chair of Geology and Eco Geology
Faculty of Geography
Herzen State Pedagogical University
nestem26@mail.ru
* Member of IGEO

45. SUDÁFRICA

Ms. Tanja REINHARDT, Prof. Dr.
Coordinator
Science and Technology Education Centre
College of Agriculture, Engineering and Science
University of KwaZulu-Natal
Reinhardtt2@ukzn.ac.za
* Member of IGEO

46. SRI LANKA

Mr. Ashvin WICKRAMASOORIYA, Prof. M. Phil.
Department of Geography
Faculty of Arts
University of Peradeniya
awickramasooriya@gmail.com
* Member of IGEO

47. TURQUÍA

Mr. Nizamettin KAZANCI, Ph.D.
Department of Geological Engineering
School of Engineering
Ankara University
Nizamettin.Kazanci@ankara.edu.tr
*Member of IGEO

48. UNITED KINGDOM

Mr. Chris KING, Emeritus Prof.
Director
Earth Science Education Unit
School of Social Science & Public Policy
Faculty of Humanities and Social Sciences
Keele University
chris@cjhking.plus.com

49. URUGUAY

Mr. Fernando PESCE GUARNASCHELLI, Prof. Dr.
Coordinator
Department of Geography
Teacher Training Council
National Administration of Public Education
ferpescegeografia@gmail.com
Contributors: Prof. Rita BRUSCHI (Department of Geography, Education Training Council, National Administration of Public Education); Prof. Mag. Darwin CARBALLIDO JUÁREZ (Department of Geography, Education Training Council, National Administration of Public Education); Prof. César CUTINELLA (Department of Geography, Education Training Council, National Administration of Public Education).

50. VENEZUELA

Mr. José Armando SANTIAGO RIVERA, Prof. Dr.
Area of Teachers Trainning
Department of Pedagogy
Los Andes University
jasantiar@yahoo.com

51. ZAMBIA

Mr. Imasiku Anayawa NYAMBE, Prof. Dr.
Coordinator
Center for Integrated Water Resources Management
School of Mines
University of Zambia, UNZA
inyambe@gmail.com
* Member of IGEO

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Education
Organisation

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