TRANSFORMATIVE RESEARCH ACTIVITIES
CULTURAL DIVERSITY AND EDUCATION IN SCIENCE

RESEARCH AND PRACTICE IN SCIENCE EDUCATION: A CROSS COMPARISON OF NATIONAL SURVEYS

TRACES is **T**ransformative **R**esearch **A**ctivities: **C**ultural diversity and **E**ducation in **S**cience

Partner institutions

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1. Introduction

This report is an important milestone in the development of TRACES. It closes the first phase of the project – a survey on the research-practice gap focused on the teachers - and sets the ground for the second – a field study to look at the same issue *in vivo.*

We summarize and compare the surveys carried out by partner research groups in each of the six countries constituting the TRACES consortium, looking at them through a number of lenses emerging as most suggestive even if not exhaustive of their rich contents. The complete reports of the national surveys are available as project deliverables n. 2.1-2.6.

Despite the broad diversity of the national contexts covered, the surveys are based on a common rationale and share the core research tool: the questionnaire for the teachers in the large-scale sample, which was agreed upon in its final form during the first TRACES consortium meeting. Other research tools used on the small scale, like interviews and focus groups, had their protocols developed separately in each country in order to adapt to the local context and preliminary large scale results.

The national surveys also include the results of a Desk Research based on both official documents and independent studies and intended to frame the overall discourse in the national science education scenario with particular reference to the themes addressed in the Field Research. The focal themes of the Desk Research were common to the whole consortium and included items such as: the national science curricula, teacher training and selection, assessment methodologies, availability of laboratories and other experimental resources, public perception of education and teaching.

Based on the elements emerging from an analysis all national surveys and the discussion followed at the consortium level we propose a number of indications for the upcoming Field Actions in which all partners will enter the school to address TRACES research questions *in vivo* working together with teachers and all actors involved in the system.

In the next section, we describe the process that brought the consortium to this report through the national surveys and a 3-day workshop in which the researchers involved in the surveys worked together to compare their results and develop a common strategy for the upcoming Field Actions.

In section 3, we summarize the survey sample composition in the different partner countries and the strategies that were adopted by each partner research group to reach their samples.

In the section 4, we report the elements emerging from the national surveys as the most significant and indicative for the future development of the project.

In section 5, we present the indications for the TRACES Field Actions based on the national surveys and the further contributions provided by all TRACES research groups.

2. The path to the Indications

This document is the result of six months research and discussion carried out in each TRACES partner country and brought together at the consortium level through periodic meetings and exchange of perspectives and materials.

We think that outlining the path that led to our conclusions may help the reader understand the premises they rely onto, the context in which they were drawn, the framework for their applicability.

TRACES is a transformative research project designed and developed by researchers in science education in six different countries: Italy, Spain, Israel, Argentina, Brazil and Colombia. The composition of the consortium implies a rich diversity in terms of culture, language, public perception of science and science education, education systems.

The first challenge of the consortium was to bring together researchers from such diverse backgrounds and have them share a common rationale for the research and actions implied in TRACES.

The focus of the project being the gap between research and practice in science education, a common ground had to be defined in terms of theoretical assumptions on what was intended as research and what to look at when studying actual practice first through the national surveys and then the Field Actions in the schools.

2.1 The research framework

A general assumption framing the entire TRACES research is that logical forms (with their distinctive properties) originate from the activity of inquiry and concern the control of the inquiry itself, as regards its operative aspects and *warranted assertibility* of produced assertions. This means that logical matter is not actually separated from the methodological one, as well as conceptual aspects have to be considered together with operational procedures. In this view, inquiry can be considered as a controlled transformation of an undetermined situation into another one, which is determined – as regards its constitutive relations and distinctions – so that the elements of the original *situation* are converted into a unified whole. Here situation means a comprehensive context where events, objects, judgments, ideas are connected with one another: its unitary quality regulates the selection of observations and their disposition in a conceptual framework [3].
Moving from this position, the TRACES field research is intended as a kind of *design study*, in that it will be characterized [7] by the following strategy

1. Consider the teaching/learning processes in an ecological view, in the sense that the contexts where the inquiry will be conducted are accounted as interacting systems rather than a collection of activities, distinctive features or factors influencing particular results: in fact attention will be paid to several levels and involved subsystems, namely the level of the consortium as a whole, the level of local school systems (in each involved country) and the single-school.

2. Explicate the theoretical assumptions which drive the design of the activities to be conduced and which one can refer to as the explanatory framework, in an iterative and continuous self-customizing process where the particular practices redirect to the main ideas and vice versa. This implies defining in what way the theory informs prospective design.

3. Have a highly interventionist character and "engineering form": the request of explicit choices in the design and conduction of the activities forces to select (and make intelligible) the aspects of the learning process which it is inquiring with most emphasis versus the ancillary ones, assumed as background components, so that they remain in a low-analyzed consideration.

4. Refer to designed and conducted experiences as "paradigmatic cases" of a broader class of phenomena, even if they are realized in a limited number of settings.

As regards expedience and adequacy in the teaching/learning practice in a multiple-level view (point 1.), the TRACES Field Actions are intended to work on three different scales, keeping integration among the typical aspects of each one: each involved school will be considered as a whole (composed of teachers, learners, principal, objectives, strategies, rules, material and financial resources, constrains, internal and external relationships, pressures from the context and so on).

According to request of straightforward assumptions defining the research framework, at the wider level of the inquiry we assume that a culture of education useful to orient effective educational practices has to

a. Refer to *theories of mind*, that is ideas about the ways to organize and use information, as well as about the processes of creation and transformation of meanings. More precisely, a theory of mind that be significant as regards the educational purposes has to provide indications about necessary resources for an effective work of mind: not only mediums (as "mental tools") but situations and conditions useful to adequate learning experiences and to making sense [2].

b. Build bridges and channels between the *common sense*, meant as a cultural system [5], and scientific culture with its conceptual architecture and its operational aspects. This entails several issues, for example: distinction between *common* and *scientific* concepts; use of the latter ones in the daily contexts and their rooting in the complexes characterizing the former ones [6]; attribution of meaning to symbolic systems in a cultural context [1]; explication of the epistemology of teachers. These matters can be explored designing and analyzing educational paths moving from the students' views and explanations as foundations of the knowledge to be built (overturning the old idea of the educational experience as a correction of misconceptions).

c. Refer to the *knowledge forms* that are considered relevant: specific and restricted performances, access to rich and wide complexes of information, comprehension of conceptual systems.

d. Refer to *teaching ways* (as a problem of *mediation*), for example clarifying the opportunities to adopt a transformative model versus a mimic one, or accounting for a balancing between base ability and creativity [4].

The above assumptions outline the theoretical framework (point 2.) for the design of the research activities: they provide lenses for the related interpretations and describe what we mean as a contribution of research to educational practices.

In detail, the interest lies in

i) highlighting the structural difficulties which oppose, in ordinary scientific education practice, to take elements a.-d. into account, and the strategies to relate to those difficulties;

ii) contributing to the debate about most effective strategies to face those difficulties and design and carry out educational paths in the area of science which are significant and understanding-oriented: this objective can be addressed by confronting, merging and sharing particular contributions coming from each local experience.

Therefore, at the operative level we will aim to inquiry on teacher preparation plans, organization and management of teachers work, on their opportunities e means to influence and criticize the official recommendations, on the grade of autonomy in designing and modifying the curricula, on the collocation of teachers beliefs in the larger cultural landscape by means of questionnaires, interviews, focus groups, observations.

On the other hand, it will design and conduct classroom experiences, which as well are intended as design studies, where the frame of theoretical assumptions will consist of a specification of the four general elements (a.-d.). Therefore, classroom activities are designed as paths explicitly referring to those theoretical lenses and are aimed to highlight exemplar *trajectories* allowing to underline questions, problems, resources, opportunities coming from that kind of approach.

The interventionist character of the research (point 3.) is warranted by a continuous communication, a sharing of perspectives among the involved subjects, that is, the entire consortium (at the broader scale) and the working local groups (at the scale of the field actions).

From a more defined methodological view, the inquiry can be conducted following an *interpretative* (hermeneutical) approach [1; 5], so that it will aim to make the actions explicit for each relevant aspect: the connections between operational choices and factual aspects, on the one side, and beliefs and ideas of the involved people on the other one, having the cultural context as unifying background.

The option for an interpretive approach means the classroom actions will go together with analyses of narrations, texts, interviews, discussions and other forms of explication.

The qualitative criteria for the sampling determine the kind of correlations that can be established among the different local experiences and the paradigmatic character of the inquiry (point 4.), or at least the possibility that the inquiry indicatively concerns spheres

and contexts larger than the experienced ones. This is the reason for paying a special attention to the sample stratification, which is crucial here for what regards the reflections that can be produced as a result of the inquiry: aspects inherent to variety in the socio-economical composition of the population and inclusion of distinct school grades can be common elements among the samples in the different countries involved.

2.2 The national surveys

The first research phase of the TRACES project consisted in six surveys conducted in each partner country with the aim of validating our research hypotheses and fine-tune the foci of the upcoming field research.
The main target of the surveys was identified in the teachers, as they are the main actors of the educational practice. Nevertheless, the systemic approach defined in the research framework implied that we were to look at teachers as related to the broader context, including colleagues in the school, principals, students and their families, networks with other schools, policy makers, status in the society and public perception.

The discussion among the researchers in the consortium coagulated in a common questionnaire to be administered to teachers in all partner countries, with small changes related to national peculiarities and translation. Questionnaires were piloted with a small number of teacher and fine-tuned before being administered.

The questionnaire defined the research questions for this phase of the project in greater detail than did the shared theoretical framework. The themes addressed included:

- beliefs about founding ideas (theories) of science teaching and their connection to practice;
- aims and social role of science and/or science education;
- interaction with colleagues;
- perception of national initiatives and official indications on science education;
- perception of pre- and in-service training;
- barriers to effective practice;
- sources of materials/ideas for teaching;
- role of assessment procedures;
- sources vision of effective science teaching;
- role of external actors in school practice;
- gender related issues in teaching/learning.

In each partner country, the same themes were inquired in greater depth conducting personal interviews and focus groups with smaller sample populations. Besides teachers, other actors involved in the system of education were included: school principals, local and national administrators and policy makers, researchers in science education and teacher trainers.

Whereas personal interviews provided qualitative data in order to gain deeper insight into individual perspectives, focus groups allowed for elements to emerge from debate among different individuals both in the same category (teachers, principals etc.) and from different categories in mixed groups.

Involving different stakeholders allowed not only for addressing survey issues from different perspectives than the one of teachers, but also to build relationships that will support the whole development of the project.

Researchers in science education were asked to address the research-practice gap and other key TRACES themes in the framework of TRACES objectives. Their perspective as recorded through interviews and focus groups provides fruitful insights for the design of the Field Actions.

The perspective of policy makers was considered another fundamental contribution to the survey investigation. Furthermore, involving policy makers in the early stages of TRACES development accounts for a participative vision of transformative research, which implies are not regarded as mere receivers of research results but as an active party in the process. We are convinced that this is also a key element in view of an effective impact of the project.

As a consequence of their more context-dependent nature and the necessity of being based the preliminary results of the national surveys, interviews and focus groups had their protocols designed locally in each partner countries (see annexes to deliverables 2.1-2.6). All protocols were nevertheless shared within the consortium prior to their implementation.

The national surveys also include the results of a Desk Research intended to frame the overall discourse in the national science education scenario with particular reference to the themes addressed in the Field Research.

The Desk Research is based on both official documents and independent studies or publications in order to give a sense of how things are supposed (or intended) to go and how they go *de facto.* In each partner country, researchers looked at the significant reforms and initiatives related to (science) education and the way these have shifted pedagogical and didactic paradigms, the foci of science education, the methodologies fostered.

Desk Research in each survey accounts for aspects of the school system addressed in the large-scale teacher questionnaire and other relevant themes including:

- national curricula (for science);
- number of years of compulsory school;
- how science teaching is arranged at the various grades (e.g. one common science subject or different subjects like physics, chemistry, biology, etc.)
- pre- and in-service teacher training;
- teacher selection;
- assessment of learning;
- interaction among teachers;
- availability of laboratories and other experimental resources;
- relationship to research;
- funding of research and development programmes.

Parallel to the Desk Research, data collection and analysis were carried out in each partner country during Months 02-05 and the reports circulated at the consortium level on the internal deadline of November (Month05) 20th. This allowed for all partners to learn about findings in one another's country and prepare their considerations for the upcoming consortium workshop.

2.3 Consortium workshop and summary of the surveys

As planned in TRACES work package 3, a consortium workshop was organized at the beginning of Month06 for all researchers involved in the national surveys to come together, discuss all surveys on a common basis and set the ground for the present report.
After each group had presented their national survey groups of researchers from different partner countries were appointed to review all reports and present their considerations at the consortium level. The cross-review process let further elements emerge that had not been included in the report and provided a rich spectrum of perspectives on one another's findings.

An important outcome of the consortium workshop was a more detailed definition of the target group of the TRACES Field Actions. It has been agreed that the Field Actions will invest in average 15 schools in every partner country. The schools will be involved on two different levels. A core group of 4-10 schools (green in Figure 2.1) will be involved in a continuous interaction along the whole period of 12 months defined in the grant agreement. A larger number of schools (blue in Figure 2.1) will be involved in initiatives

including workshops, focus groups and telematic interaction through the project portal. In the core schools, in depth studies will be carried out of a limited number of involved teachers.

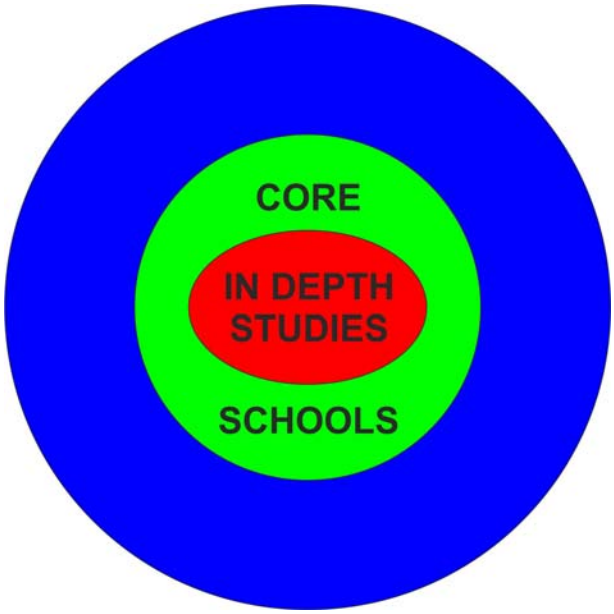

Figure 2.1 – Levels of schools' involvement in TRACES Field Actions

The final outcome of the Field Actions is a number of case studies in each country. The case studies can cover the single teacher, the single school or even a small number of schools as in the case of the Brazil (below). The key point is that in each case study the systemic aspects at the school level should emerge.

Case studies in each country will share a number of key aspects, including:

- interaction between teaching strategies and constraints/barriers to the implementation of those strategies;
- the interaction with the researchers;
- the interaction with colleagues (science department in the case of secondary schools);
- the interaction with the other schools involved in the single country.

Based on the insights emerging from the consortium workshop, the TRACES coordination team (who is in charge for the present report) identified six main themes through which to analyze and summarize national reports and produce common indications for the upcoming Field Actions. All partner research groups were asked to provide information on the selected themes completing and enhancing those already included in their survey reports. The documents provided by each partner during Month06 are appended to this report (see Appendix B).

This report is based on the contents of the six national surveys reports, the discussions conducted during the consortium workshop and the further contributions provided by partner researchers thereafter.

3. General composition of the sample populations and strategies in each partner country

We want to report in detail about the strategies adopted to reach the survey samples in each partner country, not only because this documents a part of TRACES as a process in its development, but also because it accounts for the kind of collaborations that were established locally and that will support the further progress of the project and for its impact on each the national education system.

Although it is impossible to estimate the exact number, altogether the TRACES national surveys reached dozens of thousands of teachers, principals, researchers and policy makers in the six partner countries.

Among all partner countries 1900 completed questionnaires were collected and 165 people participated in interviews and focus groups. A detailed record per country is presented in Table 3.1.

	Argentina	Brazil	Colombia	Israel	Italy	Spain	Tot
Large scale	**479**	**145**	**215**	**64**	**709 (+81)**	**207**	**1819 (+81)**
Small scale	**12**	**29**	**30**	**34**	**45**	**15**	**165**
teachers	**3**	**7**	**30**	**8**	**40**	**7**	**95**
principals		**8**	**-**	**3**	**(81)**	**5**	**16**
researchers	**4**	**9**	**-**	**10**	**4**	**1**	**28**
pol. makers	**1**	**5**	**-**	**6**	**1**	**2**	**15**
t. trainers	**3**	**-**	**-**	**7**	**-**	**-**	**10**

Table 3.1 – Detailed large- and small-scale survey samples per country

In many partner countries, data collection has been kept active beyond the date when data analysis was started. In Italy, for example, the total number of contacts to the questionnaire online form has raised to 1197 at the date this report is being delivered.

The strategies adopted in order to reach the survey sample population implied in most cases an interaction with institutional organisms of far larger significance than was expected when TRACES was devised. Representatives of ministries of education or local administrations, national evaluation institutes, research and development programmes, national institutes for the development of curricula and teaching materials, teacher training centres have learned about TRACES activities and objectives and provided their insight into the issues under investigation. We expect these to be relationships that will limit themselves to the first stage of the project but be fostered throughout a continuing dialog that will inform and support the Field Actions as well and build the basis for a positive reception of the project's outcomes.

3.1 Italy

As the coordinator, the Italian team was the first to develop a proposal for the research questions for the surveys and to produce a preliminary version of the questionnaire for the large-scale sample. The preliminary questionnaire was piloted in Italy with a small number of teachers and the first changes applied accordingly.
Consistently, a sketch of the possible stratification criteria of the sample and the strategy to reach it were devised.

All the documents produced in the process were circulated to the whole consortium and discussed in the first online meetings held during Month01 (July 2010).

This allowed for all partners to meet at the end of Month01 (on the occasion of the first project Steering Committee meeting) with a solid basis to work upon. The discussions and reflections carried out during the meeting produced the common criteria for the national surveys reported in Deliverable D1.2. In particular, a common questionnaire for the large-scale teacher sample was developed (see Appendix A) and national strategies for reaching the sample were shared.

In Italy, a questionnaire was also developed in order to reach a large-scale population of school principals. Both the questionnaire for teachers and that for principals were published on the Internet as an online form.

Italy has an overall population of 60 Million spread over 20 regions often representing a diversity in cultural and social background that has survived the short unitary form of the Country. In particular, a historic gap in the economic development distinguish the northern regions as compared to the southern ones is reflected in the results of many international surveys on education (such as PISA).

Based on the national context, the five criteria were identified for sample stratification were identified as

- *geographic area* (northern, central, southern);

- *social context* (big city-centre, big city-peripheral, medium city, small city);
- *school grade* (elementary, 1st and 2nd grade secondary);
- *presence of foreign students* (more or less than 20%).

In order to reach the largest number of people while avoiding possible biases, a collaboration was started with the Service of Statistics of the Ministry of Education (which is the national reference institution fur studies such as those carried out by Eurostat and OECD).

The Service provided a random list of 500 schools that would significantly cover the proposed stratification. The rest of the sample was reached through explicit invitation sent to individuals or associations (e.g. the National Association of Science Teachers, Association for Science Education, Association of Catholic Teachers).

In order to be account for possible biases in the overall sample, all different groups were assigned a different code, so that the answers could be tracked as belonging to each group when the data were being analyzed.

At the time when the data analysis was started over 900 teachers and 250 had accessed the online questionnaire and respectively 734 and 81 complete answers were collected.

For what regards the small-scale, in order to be able to cover different areas nationwide the interviews were administered as open questions in a written form and collected via electronic mail. In addition, four focus groups were conducted with four different groups of teachers.

Altogether, 32 teachers were involved in focus groups. Another 8 teachers, 4 researchers (in the areas of biology, chemistry and mathematics education), and 1 technical officer of the Ministry of Education were interviewed.

3.2 Argentina

Despite the very large total area (comparable to that of India), Argentina has a rather small population of approximately 40 Million. Similar to other South American countries, the population is very diverse in terms of ethnicity, religion, language and socio-economic conditions. There are few large urban centres and many small communities, often isolated. In many indigenous communities, schooling is provided in the original language.
The Field Research for the Argentine survey was conducted in the region where the partner institution is located, the Province of Salta. The region has a total population of around 1 Million which is however comparable to that of the entire country in terms of diversity.

The large-scale sample was stratified along to the following dimensions:

- *social context*

- *geographic area*

- *school level* (kindergarten and primary school)

The teacher questionnaire was translated, piloted and fine-tuned accordingly.

Because internet connection is often not available or stable in a large number of the schools in the Province of Salta, the Argentine researchers decided to distribute the questionnaire on paper. A special mailbox is enabled, to which responses can be sent free of charge.

In order to define the large-scale sample, a collaboration is established with the local coordinators of the Scientific and Technological Activities for Youth, a national initiative fostering school projects in S&T activated in 1991. The resulting sample is expected to cover the different departments of the Province of Salta, represent the socio-economic and ethnic diversity and include a minimum number of teachers in special education schools (e.g. those for gifted children).

In order to establish contact with the schools in the sample an agreement is settled with the Directorate of Primary and Early Childhood Education, which provides official authorization for the survey.

The interaction with the Directorate proves being a strategic move for the overall impact of the project. The Board of Supervisors recognizes the topic of TRACES as one addressing important issues of the local school system and offers full cooperation during the survey phase. The Board requests access to the results of the investigation as a source of information meant to inform curricular policy.

Due to the particular geography of the region, some schools in the sample require special transportation means to be reached. For this reason, another collaboration is established with the General Directorate for National Parks.

Altogether, 3,500 questionnaires are distributed in 600 envelopes. Many schools are later contacted by phone in order to encourage participation and some questionnaires are collected personally by the research team. The total number of collected questionnaires at the time when the analysis was started is 478.

On the small scale, 12 individuals were involved in personal semi-structured interviews, including 4 Researchers in science education, 1 policy maker (the Province general supervisor for primary school), 3 primary school teachers and 3 teacher trainers.

3.3 Brazil

The dimensions of Brazil both in terms of surface and population are far from being comparable to those of other countries involved in the TRACES project, especially the European ones. The total population exceeds 190 Millions and covers a unique diversity of ethnicities and cultures.

For the Field Research part of their survey, the Brazilian team restricted their focus area to the state of Rio Grande do Sul, where their institution is based. Although it has fewer blacks and natives than other Brazilian States, Rio Grande do Sul features significant socio-cultural diversity which is comparable to that of the whole Country. The State includes mountain and pampa-like areas, hot and cold regions, urban and rural settlements and diverse socio-economic milieus, although it is in average one of the richest in Brazil.

The common teacher questionnaire for the large-scale study was translated and slightly adapted to the national context and fine-tuned after piloting with 16 teachers.

The resulting national questionnaire was published on the internet and answers collected via electronic mail.

The dissemination strategy implied the involvement of regional education coordinators, training programmes and research networks. Invitations were sent also to private teachers of the Marist Brothers civil institution, teachers involved in in-service training courses at the Pontificia Universidade, the members of the Network of Research in School (a state education innovation exchange network) and the teachers participating in the 30th Chemistry Teaching Debate Meeting. The letter of invitation included also a request of promotion of the initiative to other colleagues. No differential codes were assigned to keep track of the different groups.

The sample was stratified according to four dimensions:

- *geographic area*: centre, south and north of state (consistently with economic differences);
- *type of school*: state, municipal and private (consistent with the fact that there are schools run by the state, municipalities and private schools. National schools do exist, but are rare);
- *school level*: secondary school (6-9) and high school (10-12);
- *social context*: urban, suburban, and small town (consistent with the fact that the location of the school strongly affects the quality of education, as a result of social inequalities).

The Brazilian team estimates that approximately 1000 teachers were notified of the questionnaire. The analysis of the data started on November 15th, when the total completed questionnaires were 145.

On the small scale, 29 individuals were involved in interviews and focus groups, including: 8 school principals, 5 policy makers, 9 researchers in science education and 7 teachers.

3.4 Colombia

Colombia has at total population of over 45 million people, 25% of which live in rural areas. It is administratively divided in 33 departments covering five geographic regions Andean, Amazon, Caribbean, Orinoco and Pacific.
The Colombian researchers of the National Pedagogical University selected three regions for their national survey: Andean, Orinoco and Caribbean. The regions were considered representative of a number of factors possibly influencing science teaching, with special regards to the themes to inquire and the kind of stratification that was agreed at the consortium level. For the specific national context, the stratification criteria assumed were:

> *Urban - rural - suburban*: the differences between these types of context in economy, work and access to services (transportation, health, information, power grids, water, etc) is assumed to affect school life.
>
> *City – region*: the political and administrative organization of the Country and the differences in history, geography, economy and culture can provide distinctions in school contexts. Through the information collected in the cities chosen to apply the large-scale survey, these differences are expected to emerge.
>
> *Migration*: different types of migration, either by work activities or by the different ways of the conflict, are assumed to affect the school context. The sample included population will cover schools with a significant percentage of migrant population.
>
> *Primary – secondary school*: the differences in teachers training and in the organization of the education system in different levels (preschool, elementary and secondary), affect practice in science education.

In each of the selected regions, a team of researchers was established. The Ministry of Education was contacted and informed about the objectives and strategies of TRACES. Meetings were organized in order to disseminate the national version of the TRACES website and the online questionnaire url. Some questionnaires were collected personally (on paper).

A database of teachers in each region was obtained directly from the Ministry on Education. These teachers were contacted directly and invited to fill in the online questionnaire. Other teachers were contacted through graduate and undergraduate programmes of the Department of Physics and training events organized by members of local TRACES team. Colombian researchers reported, however, that this strategy didn't prove very effective and there were proportionally few surveys collected through this channel.

The rest of the questionnaires were distributed on paper during meetings organized in each sample region.

In the **Caribbean region**, taking into account the specificities of the region in terms of educational dynamics and relationships with administrative and educational communities in the region led to the following strategy.

The project was disseminated at different levels: both the Secretary of Education of the District of Santa Marta was involved and core managers and supervisors who preside over the academic and administrative coordination of the various institutions set up by regional Districts. A regional meeting was organized on October 22 2010, to which 140 people were invited, including 80 science teachers.

In the **Orinoco region**, the Union of Teachers played an important role as the link between the administration and the academy. The proposal was well received among the higher authorities of the Ministry of Education because it was assumed as an initiative of the teacher's organization that provides opportunities for training and qualification practices.

A regional meeting was held on October 29 2010, with 60 local teachers participating.

In the **Andean region** (which includes the Department of the capital city Bogotá), several Secretaries of Education including those of the Municipalities of Facatativá and Mosquera in the Cundinamarca Department. Meetings were organized with the local Undersecretary of Education and the Secretary of Science and Technology. In these meetings the relevance of initiative like the TRACES project for education of the District was discussed. Colombian researchers report that, although these meetings didn't prove effective in terms of concrete effects in the application of the survey, they represent an important effort in order to extend the impact of the project as well as strengthen the bonds between the Secretary of Education and the National Pedagogical University.

The meeting of the "Foro Distrital" was also exploited to disseminate the survey in the Andean region. The 400 teachers taking part in the meeting were informed about the project and 200 of them were involved in the survey.

Further dissemination in this region was carried out both online and in print using the contacts of the core team with the teachers graduated from the undergraduate and graduate programs of the Physics Department.

In total, 215 complete questionnaires were collected and analyzed and 30 teachers were involved in interviews and focus groups in Colombia.

Taking the local context into consideration, the Colombian research group refers to this result as successful. They also motivate the high overall receptivity towards the project by both teachers and administrators in terms of the high credibility the National Pedagogical University enjoys as the governing body of teacher training and discussion on education in the country.

3.5 Israel

Israel is a small but very special country in terms of cultural diversity because of the cohabitation of Arabs and Jews and the complex history of Jewish immigration from the most different parts of the World. The total population is approximately 8 Millions, of which 75.5% are Jews and 20% are Arabs. Around 5% of the total population are ultra-orthodox religious Jews who maintain independent education systems, in which normally no science is taught.
Due to the specificities of the local context, the Israeli research group considered that it would be nearly impossible to reach a significant large sample for the quantitative survey in the time at disposal. They therefore opted for a large number of in-depth interviews as the core of their national survey.

Nevertheless, the questionnaire developed at the consortium level was translated into Hebrew and published as an online form on a page of the Science Teaching Department of the Hebrew University. An invitation to questionnaire was disseminated through the websites of all the five National Science Teacher Centres. The centres include teacher centres of science and technology (middle school) as well as physics, chemistry, biology and earth science (high school).

Three teacher centres published the invitation letter and the link to the online questionnaire on their website (middle school science & technology, chemistry and physics). The other two sent the letter by email to their mailing list. In total, 65 completed questionnaires were collected, largely exceeding researchers' expectations.

On the small scale, 34 in-depth interviews were carried out with a sample of stakeholders composed as follows:

- 10 science teaching researchers (academics, leading in education research);
- 6 policy makers (administrators and supervisors of the Ministry of Education);
- 7 teacher educators (trainers of pre- and in-service teachers, some of them researchers as well);
- 3 school principals;
- 8 science teachers (experienced teachers, some of them have leading responsibilities).

The interview sample was devised taking account of a number of aspects representing the rich diversity of the national context. It was stratified according to the following dimensions:

a) different institutions;

b) geographical areas;

c) religious identification: Jewish, Arab (Muslim or Christian);

d) socioeconomic background of the pupils;

e) ethnicity (e.g. Ethiopian, Russian);

f) education level: high-school, middle school, elementary school.

In Israel, any educational research in the system of education requires the approval of the Ministry of Education in order to be carried out. Israeli researchers had to prepare a formal application describing the detailed description of the study and its tools. The letter was sent to the chief scientist of the Ministry who is responsible for allowing research activity in schools, including survey, experimental teaching, video and audio recording of the activities, interviewing individuals employed by the ministry of education, using school facilities. The permission was received after a few months of consideration process.

3.6 Spain

The Spanish survey was restricted to the Autonomous Community of Catalonia. This decision was based on decentralized character of the Spanish educational system, in which autonomous communities are in charge for managing curriculum development and school organization under the umbrella of the national regulations.
This situation makes for other important international surveys and evaluations also to focus on the different regions of Spain differentially, as it is the case of the PISA and TALIS studies.

Catalonia is the second most populated autonomous community in Spain, with a population of approximately 7.5 Million inhabitants (representing 16% of the total population of the Country) and an immigration rate of 12.5%.

The characteristics of the Catalonian school system include a substantial private sector, with students in private schools usually performing better in science than others (specially in primary schools), significant immigration rates in the most populated areas of the region and different organization of teaching in the different levels, primary school teachers teaching all subject and being mostly non-science specialists.

The large-scale Spanish survey sample was designed in order to cover consistently the three dimensions, considered as suggestive of a meaningful stratification.

In order to build a consistent database of schools, Spanish researchers worked together with the *Serveis Territorials*, the local education services representing the Department of Education of the *Generalitat de Catalunya*.

The nine Catalonian district services were contacted by phone and email in order to spread the survey via official channels. Eventually, only two of them accepted to send the questionnaire to the schools under their jurisdiction.

Administrative support was also asked via the General Centres of Resources for the teaching of science, which is an educational service belonging to the Department of

Education (the main authority in education in Catalonia). They accepted to distribute the questionnaire within their internal database both of primary and secondary schools.

Apart from these official channels, the Spanish team also exploited the database of schools provided by their institute of reference, the Research Centre for Science and Mathematics Education (CRECIM) of the Faculty of Education. Also, other science teachers' associations and groups of teachers usually collaborating with the CRECIM were asked to disseminate the questionnaire.

The teachers' questionnaire was published on the Internet as an online form. A general message was sent to all schools in the sample and responses collected for four weeks afterwards. The analysis was conducted on a total of 207 completed questionnaires.

On the small scale, the Spanish team involved teachers, school administrators, researchers in science education and policy makers and both personal interviews and focus groups. The sample includes 5 school administrators and 7 teachers from both private and public primary and secondary schools, 1 researcher and 2 policy makers from the section of Teacher Education and Professional Development of the Department of Education.

4. Elements emerging from the national surveys

In this chapter we want to present a cross-comparison of the data coming from the field investigations in the TRACES national surveys (D2.1-D2.6), trying to connect stakeholders' perceptions with the scenario of the national contexts as emerging from the Desk Research part of the surveys. We want to present the main analogies and differences among the partner countries that emerged by cross-comparing the national surveys, using both quantitative data from the answers to the teacher questionnaire and qualitative data form interviews and focus groups with teachers, principals, researchers and policy makers.

As a general reference for the following sections of this chapter, in Chart 4.1 we present the answers to one of the core questions in the teachers questionnaire, the one concerning actions to improve science teaching. The graph gathers together the answers given by the overall sample of teachers obtained by aggregating the national samples. The total number of answers collected is approximately 1800 (different numbers of answers have been collected for each item).

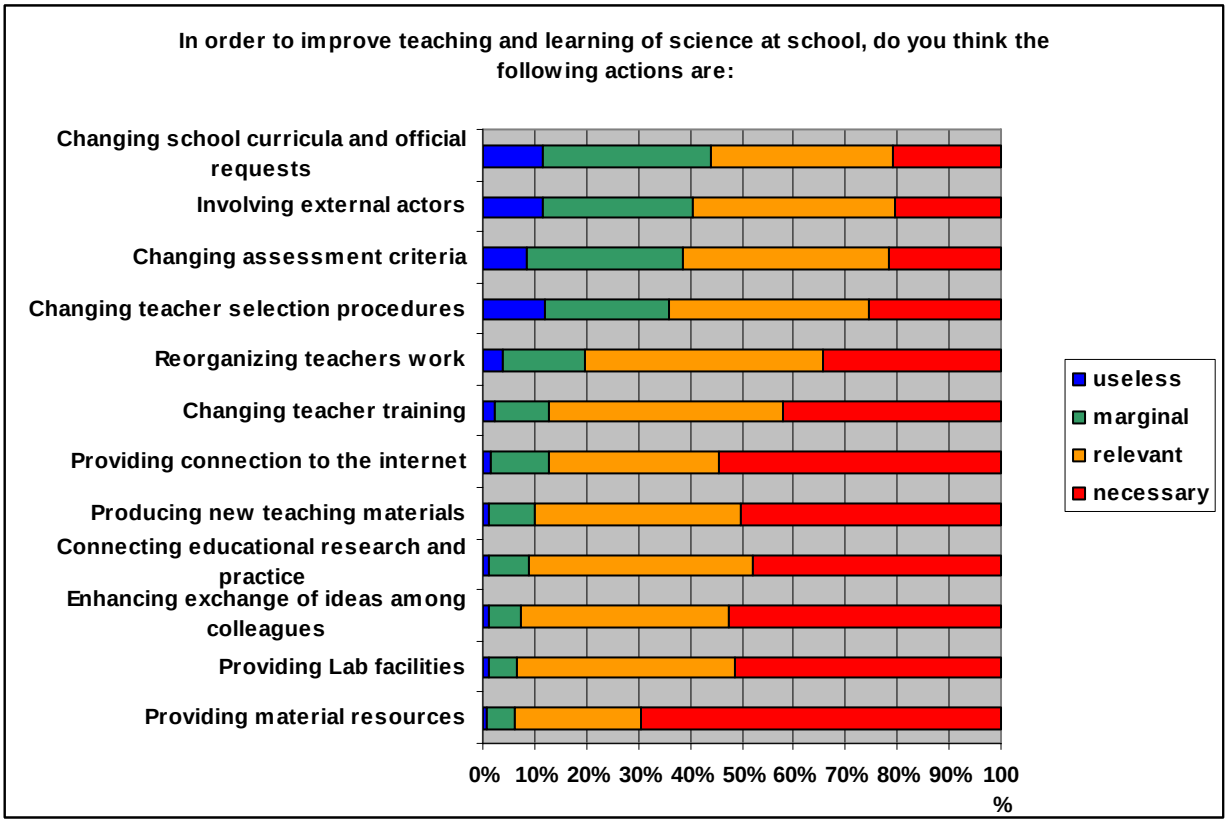

Figure 4.1 - Actions to improve science teaching – complete TRACES sample

Although the overall sample is biased by the different number of questionnaires collected in the partner countries (ranging from 64 in Israel to about 700 in Italy), some common trends emerge from the analysis of the answers to this question.

First of all, it is quite evident that the majority of the teachers perceives all the mentioned actions as at least relevant in order to improve science teaching, expressing therefore a strong need for structural changes in their actual practice. Nevertheless, a

ranking in the importance attributed to the different actions by teachers is also quite evident: the need for more material resources (including laboratorial facilities and connection to the internet) is chiefly felt as strongly relevant, followed closely by the need for circulation of ideas and materials (exchanging ideas among colleagues, connecting educational research and practice, producing new teaching materials). Interventions on the general organization of their work (changing teacher training, reorganizing teachers work, changing selection procedures) are a bit less valued, while the interventions that are most poorly valued are the one regarding changes in the assessment criteria, involvement of external actors and changing curricula and official guidelines.
The picture emerging from this rough analysis is one of teachers who want to be provided with resources (material and not material) to sustain their work and don't believe they can profit of structural reforms or external intervention (including the interaction with researchers). In the rest of this chapter we will detail this general picture and account for its different declinations in the different national contexts.

4.1 Official guidelines and teaching practice

General framework

During the last 40 years, reforms of the school system in all TRACES partner countries have been focused on guaranteeing wider access to basic public education. In all partner countries, free and compulsory education has been gradually extended towards higher school grades and nowadays it reaches the 10^{th} school grade everywhere. A parallel transformation of the educational principles underlying the general school curricula (and science curricula in particular) has been undertaken, with a consequent transformation of the main educational goals.
Starting from the Seventies, education reforms in South American countries have been strongly connected with a general concern of democratization of the society. In particular for what concerns science education, after a period in which most of South American educational systems were engaged in the experimentation of curricular projects developed in the US and UK, structural reforms developed everywhere in South America were specially committed to spreading scientific and technologic literacy with the aim of fostering the economic development. Almost in the same historical period, important reforms of the primary and low-secondary education occurred in Italy. Those reforms strongly reflect the political and cultural heritage of the student movements that had invested the Country and introduced a shift in the focus of the educational discourse from teachers to pupils. At the same time, In Spain, under the influence of the 1978 Constitution, the first official attempt to regulate educational principles, organisation of educational institutions and students rights and duties was enacted. In Israel the establishment of free and compulsory basic education dates back to the Fifties. Since then, the main issues in education policies have been connected to the strongly multicultural nature of the Israeli society (Hebrew and Arab educational institutions, large numbers of immigrants from all over the World) and with the separation of secular and religious schools (which still maintain independent curricula).
For what regards reforms of science curricula that occurred in the last decades, all TRACES partner countries share a transformation process of educational goals from content-

oriented to competence-oriented. In some countries particular attention is devoted to technological issues, while almost everywhere increasing interest has been directed towards the development of science education programmes aiming at enhancing citizens' awareness.
Coming to the present days, the main goals for science education as they are presented in the official documents are summarized hereafter.

Argentine
The recent educational policies assume science education as an aspect of the baisc literacy required for citizen's education. Science teaching is intended to foster a scientific literacy based on understanding the structure and dynamics of the natural world, on skills for experimental and exploratory study and on the use of specific representations. Science can and should be taught in such a way to "let students use it in their daily lives and spread it in a social dimension" (Federal Law of Education, 1993, curricular design of the Province of Salta, 1997).
Brazil
The official guidelines for scientific education are defined in the Parámetros Curriculares Nacionais (PCN), developed in 1998. These documents display a proposal for teaching and learning based on the development of skills and of minimum expected competencies. It presents a conception of students as active subjects in the process of learning and as subjects integrated in the reality of a technological society.
Colombia
The general approach is referred to in the General Education Law of 1994: "education should promote the full development of the learners' personality, giving access to culture, the achievement of scientific and technical knowledge and training ethical, aesthetic, moral, and religious citizens, to provide the realization of a useful activity for socio-economic development"(Article 92 - Act 115, 1994).
Israel
According to official documents developed by the Department for Curriculum Development of the Ministry of Education, educational principles underlying the curriculum include social, cultural and economic as well as epistemological considerations, the relevance of a specific discipline to other disciplines and possibilities of integration between them. The goals directing the curriculum development include mainly knowledge of content and acquisition of skills and competences.
Italy
The considerable number of official guidelines and curricula produced over the last 30 years (exception made for second grade secondary school, which has gone through a complicated pathway of mutually cancelling reforms) share a common resonance with a series of general principles such as centrality of the learner, science learning to start in primary school, laboratorial/inquiry based approach, link to everyday life, accounting for students' interests and pre-conceptions, interdisciplinarity, social aspect of learning.
Spain
Catalonia is at present in a crucial moment of educational change: a completely new curriculum both for primary and secondary education was launched by the educational authorities (DOGC 2007). The main change in this curriculum is the shift from a focus on the acquisition of contents (before organised as conceptual, procedural and attitudinal

contents) towards a competence-based framework which sets the importance on teaching for and assessing the "mobilisation and use" of these contents.

For what concerns teaching of the scientific disciplines at different school levels, in all partner countries science is taught as a unified subject in the lower grades, while different kinds of separation in disciplines occur in the secondary school: in Brazil separation of the disciplines (physics, biology, chemistry) occurs at grade 10, while in Italy at grade 9 (physics, chemistry, biology, earth science; in many of the different curricula physics only is taught in all 5 grades of high school, while the other subjects are taught in one to three grades); in Spain science is compulsory taught as an integrated subject in all the primary courses, while in the lower secondary education, science is an integrated subject for the first three years and has recently become optional in the last grade of compulsory education, including a separation of disciplines (Physics/Chemistry, Biology/Geology). Science teaching in the Israeli school system is characterized by a quite peculiar organization. Starting from the beginning of the Nineties, science and technology are taught within an integrated curriculum (instead of separate disciplines, as it used to be). A new subject called Science and Technology in the Society has been introduced, to be studied by those students who do not choose any of the science disciplines (that are all elective subjects) when passing to high school.

Impact of official guidelines on actual teaching practice

On the one hand, the desk research analysis carried out in each partner country highlights strong efforts towards the enactment of science curricula that are strongly rooted in up-to-date educational principles and goals and towards the implementation of initiatives for the improvement of science education that could enhance the actual impact of curricula and official guidelines on science teaching. On the other hand, the analysis of pre-existent research materials about the national school systems and of the data collected within the field research part of the TRACES national surveys show a wide separation between the aims of national policies and their impact on the actual work of science teachers in the classroom. The TRACES surveys identified (or confirmed) a number of reasons for this separation as they are perceived by the different stakeholders in the school system. Most of these reasons are shared transversally although they emerge with nuances that are characteristic of the different national contexts. Among these reasons are the lack of involvement of different actors (researchers, teachers) in the design of policies, the weak connection between official guidelines and the actual teaching/learning contexts, the lack of knowledge of the guidelines by teachers also in connection with the lack of relevant teacher training initiatives and teachers' inertia with regard to didactical experimentation.

In all countries teachers expressed poor interest in changes in the official requests in order to improve science teaching. This is particularly evident in Italy and Colombia, where the majority of the teachers (59,5% and 51,1%, respectively) in the survey had a judgement of poor relevance for this item when answering to the question about action to improve science teaching (Question 8[1]). In other countries the answers to this same question were different (ranging from judgement of poor relevance expressed by 15,6% of the Israeli sample to a 38,4% in Brazil), but the item is everywhere one of the less valued when compared with the others. The hint coming from the answers to Question

[1] From now on, we follow the numbering of questions of the English version included in Appendix A.

8, is confirmed in the answers to Question 1 (sources of the important ideas for science teaching mentioned) and Question 9 (sources of ideas to improve teaching practice), where the item "official documents" is very poorly represented (by far the less mentioned item). This datum is more or less common to all partner countries as summarized in table 4.1.

	Percentage of answers "official documents" in Question 1	Percentage of answers "official documents" in Question 9
Argentine	**11,7%**	**18,4%**
Brazil	**5%**	**18%**
Colombia	**not applicable**[2]	**not applicable**
Israel	**3%**	**6%**
Italy	**7,4%**	**9,9%**
Spain	**9%**	**11%**

Table 4.1 – Item "official documents" mentioned as source of ideas for science teaching in the teachers questionnaire

Choices of the other items in the answers to Question 1 and Question 9, show that the general trend is to value mainly one's own professional experience as a source of big ideas for science teaching, while resources available online, teacher training, colleagues and sometimes books and magazines are mentioned with difference strengths as sources of ideas to improve science teaching.

Let us summarize the reasons for the poor relevance (or bad perception) of official requests and documents as emerging from the national surveys.

In Israel, the Department for Curriculum Development of the Ministry of Education is responsible for curriculum design. There are different committees for each discipline, that are composed of researchers, teachers and supervisors. The development of scientific learning materials for schools is performed only by the academic staff of science teaching centres and departments at seven universities of the country. Only in very few cases other subcontractors are used for this purpose. Interviewees talked about a basic conflict of interests between politicians and educators as the following quotations well summarize:

> *A major problem in education is that politicians have short-term goals, they want quick results, and in education activities and researches take time and are long-term. This is a general problem all over the world* (researcher, Israel)
>
> *In two major reforms that were done recently in Israel there was no preliminary public discussion. A small group of people, most of them with no background in science education, made decisions with far-reaching consequences* (researcher, Israel)

[2] The item included in the Colombian questionnaire was modified to "documents", which has a different connotation.

> *Reforms should not be done top-down, but involve the target population of teachers. It should be a combination of top-down and bottom-up. At the top are the policy makers or academy and curriculum people, and the "down" are the teachers and students* (principal, Israel)

Also in Brazil, the PCN and their updates were prepared with the participation of renowned researchers from the Brazilian academic community, associated to major universities. While there are no conclusive studies regarding the impact of these indications within the school environment, some researchers point out that many schools and teachers take these indications with disbelief or disinterest. They attribute this reaction to the fact that the material was produced without public discussion of their assumptions. Researchers also underline a widespread poor knowledge of the content of the PCN by teachers. These issues clearly emerged in the teachers interviews:

> *In fact I knew about the PCN existence, but there was no effect. […] There was a teacher training course for the Technical School teachers, but it was not so fruitful. In my view, there was little applicability. It had no influence on the teaching practice. This problem is a result of the State teachers' lack of motivation and, for that, nothing help* (teacher, Brazil)
>
> *What I know about PCN is just what I studied on the undergraduate course. At school we talk about PNC in order to fill in the papers. I do not see effects, […] some teachers try to apply the PCN, but it is very rare... ...they talk about integration, but it is all foolish talk* (teacher, Brazil)

The PCN programme included incentives to experimental investigation and school laboratories were equipped on a small scale, but today there is no specific governmental program to provide the required facilities and specifically train science teachers.
In Argentine, the recent Plan for the Improvement of Science Education is the product of a process of negotiation with the participation of experts from various disciplinary fields: teachers, provincial technical teams, researchers and academics. Based on the criteria defined at the national level, each province should take the responsibility for developing their own curricula. However, also in Argentine a deep gap exists between the official guidelines and their implementation in practice. This is mainly due to the persistence of attitudes of traditional type, resistance to change from some principals and teachers and to the lack of teacher training. Some teachers, however, have a good perception of the content of the official guidelines: *"the initiatives are always looking to improve educational quality; however the implementation, teaching time, investment in training and bureaucracy threaten any action".* Also in Colombia there is strong autonomy in the development of regional curricula. In the Bogotá region, it is acknowledged that the last two local governments recognized the importance of the teacher union movement (which teachers have joined in a large proportion) in the formulation and regulation of these initiatives for education. In the Caribbean region guidelines related to curriculum development are obeyed but are not the main focus for the action in the classroom. The interviews and focus group show some resistance to the policies and regulations. In this

region, teachers, who "know and interpret their social environment", were not involved in the design of the official guidelines that are therefore not capable of taking into account the reality that surrounds educational institutions.
In Italy, official guidelines and curricula for primary and first grade secondary school produced over the last 30 years show a strong resonance with research indications. These reforms also represent a peak in terms of the involvement of subject specific education experts in the commissions appointed to define guidelines and curricula. Nevertheless, many research studies show that there is a deep gap between the official recommendations and measures actually undertaken to provide the necessary conditions for them to be enacted. Lack of material resources and of related training are highlighted as the main causes for this gap, while the lack of direct involvement of stakeholders in the design of curricula does not emerge as an issue.
As emerging from the TRACES survey, teachers consider that the official requests about science education are very rich and embrace many important issues, but at the same time have poor impact on their re actual work. Among the issues relating to this lack of impact, teachers mention their tendency to reproduce their way to teach, relying on their competences, on their previous experiences and their know-how: "*teachers do what they are able to do*". Another relevant aspect is the extent of the national curricula, which are considered too wide and diversified in contents, making it impossible to cope with them in real-world practice. Lack of training is also often complained by teachers. This issue is well exposed in the following quotation:

> *It looks as though teachers underestimate any contribution coming from outside and indirectly consider their own work in the classroom as the only possibility available. […] There is an understated lack of trust in initiatives connected to curricula reforms and maybe this is understandable: During the last years, new syllabi have been proposed by each Ministry, but they weren't supported with adequate training and counselling activities. In fact, they had little impact on school quality and every-day teachers' work* (policy maker, Italy)

In Spain, both teachers and researchers are not specifically involved in the design of curricula. Catalan teachers complain about the recent cuts on resources, about the fact that their opinions are not taken into account and about the lack of control and evaluation of initiatives that the administration undertakes. An interesting correlation was noticed between the variable "teachers participation in research" and positive answers to the question "existence of good or bad initiatives", which implies that teachers involved in research are more aware of the existence of initiatives launched by the educational administration than other teachers. A need for changes in the official requests has also been clearly expressed in the teacher survey. Particular emphasis is put on changes to the science curriculum that recently underwent a reduction of teaching hours with some of the scientific disciplines becoming elective earlier than before. The issue of mandatory science teaching is strongly debated also in Israel. Most of the people interviewed in Israel agreed that science should be mandatory in primary and middle school, up to grade 10 or 12. All the school principals, and 50% of the teachers accept the current situation in Israel, where after grade 10 science is optional.

A particular aspect in stakeholders' perceptions about the impact of official guidelines is connected with the introduction of standardized procedures for the assessment of learning, which is quite a topical issue in recent school reforms worldwide. There is almost general agreement in teachers' negative perception of this kind of tests as long as they expose to the risk of shifting the focus of teaching/learning towards the achievement of good results in the tests. In Colombia the introduction of standardized assessment methods is connected to the implementation of research and innovation initiatives in the framework of international OECD policies. While there is a general positive perception of those policies among teachers, the mandatory use of standard evaluation test is perceived as a barrier towards effective science teaching/learning:

> *Because of the attention of the international institutions for the development of scientific skills, there have been very interesting policies proposed […] which set out strategies for research in the strict sense* (teacher, Colombia)
> *[Those programmes] allowed further development of scientific competence, but there is no ownership of content, because the system distorts the assessment* (teacher, Colombia)

Colombian teachers express strong disagreement with the assessment policies, considering them not demanding enough, based on the concept of producing statistic about the quality of efficiency parameters and not addressed to evaluate the capacity to respond to the environmental issues, or academic challenges of the new citizens. In Italy, a national organism (INVALSI) was founded in order to verify that educational objectives and quality standards are achieved. Recently, INVALSI is developing standardized tests that will be introduced in end-cycle examinations at the national level. The standardized final test for the first grade secondary cycle has been applied in 2010 for the first time. One of the researchers interviewed referred to the introduction of standard evaluation tests as a barrier (among others) towards the implementation of innovative practice

> *Teachers receive and develop innovative contributions proposed by researchers in didactics only in very special situation, [because experimentations] leave little room for the development of the usual curriculum, which is well inserted in the overall system and regulated by many factors: a) higher grades standards, b) internal examinations, c) parents' general expectations and comparisons with what happens in other classes* (researcher, Italy)

One of the interviewed teachers in Israel, raise the same issue with a reversed point of view: "*if teachers don't see the reason in it then it won't succeed. Since preparing for matriculation exams is a need, then it helps to relate the innovation to these exams*" (teacher, Israel). Anyway, there is a difference in the interviewees' views about the issue of measuring success of innovation initiatives only through students' achievements in international and national tests. In Spain, external evaluation tests are considered to have on average no particular influence on science teaching (primary school teachers expressed quite controversial views, their answers being equally distributed between the

positive and negative influence items). In general, teachers with no school administration duties have a more clear tendency to disvalue this kind of assessment.

4.2 Teacher training

All the national surveys highlight teachers' general need for more specific training in order to be able to manage the contents of science curricula. The lack of specific training programmes developed in connection with the latest science education reforms is also referred to in almost all partner countries. The perceived inadequacy of preparation often leads to a difficulty in acknowledging the official requests because they are badly understood and hardly translated into practice. Teachers often refer to their own professional experience as the main instrument allowing them to manage their work in the classroom. This scenario is well represented in the answers to the teachers questionnaire. For example, Table 4.2 summarizes the percentage of teachers mentioning "teacher training" and "professional experience" as sources of important ideas for science teaching they have learnt during their professional life: while professional experience is always mentioned by a large majority of the teachers, teacher training often falls below 50% of the answers. With the exception of Israel and Argentine (where the percentages are almost equal), professional experience is by far more strongly considered than teacher training. These data have to be read together with those contained in Table 4.1, connecting the poor relevance attributed to official guidelines documents to the lack of specific training. This connection is confirmed by the analysis of the interviews and focus groups.

	Percentage of answers "professional experience" in Question 1	Percentage of answers "teacher training" in Question 1
Argentine	**64%**	**64%**
Brazil	**73%**	**45%**
Colombia	**not applicable**[3]	**53%**
Israel	**62%**	**67%**
Italy	**88%**	**39%**
Spain	**81%**	**44%**

Table 4.2 – Items "professional experience" and "teacher training" mentioned as source of ideas for science teaching in Question 1 of the teachers questionnaire

Among the issues emerging from the analysis of the survey data, we want to underline the stronger need for specific training in science education expressed by primary school teachers when compared to secondary school ones. This datum clearly emerges in Spain, where only very recently has primary teachers' initial training changed from a three-year degree without specialization in science to a four-year Bachelor's degree, including in most universities a small scientific itinerary or specialization.

[3] The item "professional experience" was not included in the Colombian questionnaire.

In Italy, the last mandatory training courses for primary school teachers date back to 1985, when new curricula were brought in. Many teachers in primary school are not graduated and they owe the core of their scientific preparation to the education they had as pupils. Therefore, those who had bad experiences in science do not feel very capable to deal with scientific arguments and opt to neglect them or relegate them to a less relevant role. On the contrary, those who had good experiences believe to be sensitive to a scientific perspective, which characterizes their way of teaching and can be strengthened through training.

Also Brazilian teachers underlined the importance of training programmes in order to improve science teaching. As reported by the interviewed researchers, in Brazil science is often taught by teachers with formation in other fields (such as Languages, History, and Geography) and teaching training courses are characterized by a strong predominance of a theoretical approach, and this practice is reproduced by students when they are in the teacher position.

In Argentine, the creation of a National Teacher Training Institute (INFOD) represents, in the intentions of the current Argentine government, a way to start a process of revitalization, development and prioritization of teacher education in Argentina. This new national institution consolidates various lines of action related to curriculum development and institutional research, professional development and student policies. Nevertheless, some of the interviewed teachers mentioned that in some cases they are supposed to develop certain themes but they do not have adequate and methodological training to address them. They also suggest that training should be continuous and free and connected to the curriculum design.

This last emerging issue is common to almost all countries and has been particularly delineated in the focus groups carried out in Italy: the training offered in the last few decades is considered confused and marked by a very fast change in the perspective. Too many and too different suggestions, procedures, tools, indications have been given, piling up without a reference framework and meaningful feedback in terms of pupils' progress: structuring education programmes as a sequence of goals and designing didactic units; use of conceptual maps; simplification; short didactic; laboratorial approach, etc. Hard work has been necessary to understand the logic underlying such a variety of approaches, get acquainted with tools and languages, try them out in the classroom. This effort has not corresponded to an actual and wide improvement in students performances.

> *It is very hard to put in practice what is required when one tries to change the way to teach, because everything relies on your [of the teacher] good will. You believe in the proposal and decide to try and check if it works. Then, taking stock of the entire experience... I worked three times as much, but the number of more competent pupils isn't tripled. So, one seldom gains enough improvement in order to justify the effort carrying out a new way to teach a lesson or conduct a laboratory session. Recognizing the defects of those approaches has been easier than catching the provided opportunities, therefore one has selected a bit from each proposal, basing on what worked better* (teacher, Italy)

In Colombia, accessibility to update and professional development opportunities is mentioned as an important source for the improvement of the level of teachers' satisfaction with their work. Teachers are generally satisfied with the offered postgraduate training but declare a lack of connection of the training courses with real-world school contexts, together with a lack of continuity in the interventions. Nevertheless, in a more general perspective, training programmes are seen as strictly connected to educational policies, with which they share an instrumental foundation, mainly aimed at enabling teachers to operate and not emphasizing reflection and comprehension as central aspects of teaching/learning.
In Israel, accounting in some sense for the different perception of teachers about training when compared with other TRACES partner countries, school reforms and large scale programmes are usually supported with the implementation of teacher training programmes. Teaching materials and other resources may be developed by the appointed national centres, in cooperation with science teaching departments or by other qualified personnel hired by the Ministry of Education. For example, current efforts in middle school science include production of teaching and learning materials in agreement with the new curriculum, followed by professional development for science teachers and a special training for leading teachers (about 300 people), who are responsible to work together with science teachers in schools all over the country. The main issue concerning training as emerging from the Israeli survey is about the lack of qualified teachers with deep knowledge in many areas in order to teach integrative science in middle schools.
Another interesting issue emerged in one of the Italian focus groups. Training and programming requires in many cases much engagement in terms of time, mental and financial resources. These efforts are not formalized and not recognized, while – for these reasons – the teachers' job is (or should be, at least) more and more ethically connoted, characterized by the search of opportunities to improve their activity.

> *- First and foremost, we need someone helps us, because we are anyway the know-it-all teachers and the main part of us is not graduated. So we need continuous training activities. But it has never happened. We are autonomously trained, spending our money, with our enthusiasm and our*
> *time...*
> *- And it was not due...*
> *- It is due, instead! We are teachers, having responsibilities. Teacher's job doesn't stop when the last school bell rings. Studying and retraining is a part of our job. In my opinion, it's due.*
> (teacher, Italy)

4.3 Interaction among teachers

Collaboration among teachers and sharing of competencies and ideas are considered as a founding value and as an important resource by most of the teachers in the overall TRACES sample. Strong relevance is attributed to training among peers and more in general to the construction of networks of collaboration at different scales. At the same time, actual

communication among teachers is often limited to issues related to the solution of organizational problems and institutional opportunities for dialogue usually do not foster a more significant interaction.
The results of our surveys show that teachers in the sample perceive interaction among colleagues as fundamental. In all countries, a large majority of the sample indicated the enhancement of the exchange of ideas among colleagues as a strongly relevant action to improve science teaching (Question 8), while colleagues are always mentioned as one of the most valuable sources of ideas for science teaching (Question 1 and 9). Nevertheless, interviews and focus groups showed that the actual situation of practicing collaboration is rather more complex. The attitude of everyone to question his/her own beliefs is considered as a necessary premise for a fruitful collaboration. Collaboration can be particularly effective when an interdisciplinary approach is used and, more in general, among colleagues who share the same concerns on students learning. One of the teachers interviewed in Italy identified a number of barriers towards an effective collaboration aimed at promoting innovations in science teaching:
- lack of esteem among colleagues and unwillingness of everyone to move from the balance reached after years of experience;
- lack of external motivation: no benefits (also economical) for the additional work to be done and poor interest by principals towards quality of educational activities;
- lack of training: without stimuli coming from training experience is even more difficult to be motivated to abandon well-established certainties.
Also some of the teachers interviewed in Brazil emphasized the lack of motivation and the pessimism of colleagues in relation to education and innovations in the classroom as barriers towards interaction.
Also some of the teachers interviewed in Brazil emphasized the lack of motivation and the pessimism of colleagues in relation to education and innovations in the classroom as barriers towards interaction.
As it is particularly evident in the Spanish and Italian surveys, the influence of interaction with colleagues on teaching practice appears to be especially important for primary school teachers, while secondary school teachers seem to have a scarce consideration of the impact their colleagues' practice has on their work. Reasons for this asymmetry can be attributed to the fact that collegiality is particularly strong among primary school teachers, who have a more stable habit to work on interdisciplinary programmes. Differently from what appears in Italy and Spain, in the Colombian and Argentine surveys, a general tendency emerges of teachers valuing their contribution to their colleagues practice more than the vice versa. The reason for this kind of answer could be identified in the large freedom that the single teacher has in determining his/her own teaching practice. As pointed out in the Colombian survey, it seems that the Colombian schools are characterized by a positive self-regulatory mechanism that is established through negotiations among teachers.
These processes of negotiation often lead Colombian teachers to create teams of teachers (interdisciplinary in most cases) that allow to focus the teaching practice on the specific needs of the single school in its own socio-cultural context. Networks including more than one school are created as a space that fosters the professional development of teachers. Colombian teachers express positive consideration towards participating in networks and strongly recognize themselves in a general vision of participation connected to political, social and didactic issues aimed at having a positive impact on

local communities. Networking among teachers is strongly valued also by Italian teachers, again with a focus on the involvement of all actors including students' families as an important factor in order to have an actual impact. As a particular aspect of networking initiatives, training among peers is considerably valued by teachers from all countries as long as it represents an important chance to share know-how and ideas with more expert colleagues. A policy maker interviewed in Italy further analyzed the issue of networking in a particularly significant manner:

> *There is an unexplored and unexploited richness of human resources and it would be easy to go through the biographies of a lot of teachers to find high-level experts also in mathematical and scientific disciplines; it is necessary to create the right bases in order to carry out this process also because it would imply very poor costs. Nowadays every innovation has to be low-cost* (policy maker, Italy)

This policy maker proposes a new possible intervention paradigm based on the promotion of the development of small-scale networks built around some special schools and the establishing of resource centres to share educational experiences on a larger scale. Such networks would allow the development of peer-to-peer training programmes, exchange of experiences, educational research projects.
In parallel with the appreciation of collaboration and networking as opportunities for a collective cultural growth, teachers in all countries notice that unfortunately most of the interaction among colleagues is generally devoted to organizational issues, such as students' misbehaviours, the management of conflicts or the accomplishment of bureaucratic duties, that are often the main priorities in teachers' work. Official modalities of interaction are often not mandatory and does not represent (at all school grades) a guarantee for actual cooperation and are on the contrary often perceived as very poorly constructive.

4.4 School organization

Another main issue emerging from the surveys is connected to structural barriers towards the improvement of science education that are characteristic of the national school organization. Among these barriers the more recurrent ones are the organization of teachers' work (mainly in terms of timetables) and the lack of materials resources. Interaction with school administrators is another point on which attention has to be focused, confronting teachers' perception about structural issue with the one expressed by principals.
Starting from time officially devoted to collaboration among teachers, in Brazil, the interaction among teachers in schools is not structured, depending on the opportunities given by the school principal, by pedagogical projects and by individual initiatives. As a general perception, teachers report the lack of opportunities and of extra time for discussion and planning meetings with colleagues. In Italy, primary school teachers complain about the poor flexibility in the timetable, that leave little room for the interaction among colleagues. Although two hours per week are institutionally devoted to programming, the planning of activities in mathematical and scientific field is rarely

developed, this eventuality depending on the principals (that suggests) and on the school board (that decides). In secondary school there is no time expressly devoted to share programming, except for a few hours at the start of school year. Italian teachers notice that devoting hours to programming is not sufficient to have good results, as far as programming is limited to make a bureaucratic list of goals, without paying attention to "how" they can be reached and "how" the activities in classrooms are conducted. Spanish teachers complain about a general lack of collaboration among colleagues, claiming a negative role of school administrators in facilitating interaction. Concerning the factors that have a positive influence on the teaching practice "interaction with the school administration team" is rated mainly as a positive influence, although this answer could be biased by the over-representation of teachers with school-management positions in the Spanish sample. In Israel, teachers see the principal's impact on their work as depending on his/her attitude: "*When the school management is supporting, encouraging, favouring, providing resources and giving positive feedback, then the students and teachers will succeed. But when the principal see the innovation as a bother, a bad necessity or something against his agenda, then teachers will have difficulty to raise it*". On the contrary, Brazilian teachers claim that no impediments to the development of innovative proposals come from the principal and the administration of the school. The reduced amount of hours dedicated to joint planning and the overload of hours in the classroom for the teacher is identified as the main reason for difficulties in the interaction among teachers:

> *If he/she is a teacher in fifteen classes, forty students per class, he/she has six hundred students. Therefore, he/she spends in the school three turns, each one in a different school, […]he/she is not in accordance and does not recognizes himself/herself in the pedagogical project [of the school]. […] There is just one argument stored in the drawer and you are not able to recollect the name of the students… […] Thus, the not belonging to the school, the absence of real pedagogical project, supported by the teacher; all conspire not just against the Science teaching, but against the teaching in general. […] The difficulty of doing a significant education bumps in these very operational conditions of the school, not just in the teacher's initial formation and in the need of adequate materials* (teacher, Brazil)

Lack of recognition and incentives, large number of students in the classrooms, lack of time and material resources are generally identified in all countries as the main structural barriers that prevent teachers from being motivated towards a more innovative and effective teaching of science. The general perception of teachers about their work is well summarized by an Israeli teacher who claims that "*the teacher is the victim of reality*".
Coming to the point of view of school principals, their main claim is shared with teachers and concerns the general perception of a strong lack of material resources, with special reference to the lack of lab-facilities addressed to the improvement of science teaching. In all countries, principals also claim the lack of teachers' adequate preparation in scientific contents and teaching methodologies, together with the lack of motivation among teachers, that makes it hard to implement innovation programmes. Teachers are seen as pursuing out-of-date teaching approaches, mainly based on the use of textbooks

as the main resource. The structural need for a better selection of teachers is connected to the limitations in the role of the principal himself, as is well summarized in this quotation from the Italian survey:

> *The principal is an employer and as such should promote quality, but he faces a lack of control. At present, the inclusion of teachers in an employment list is the only available selection criterion due to the pressure of trade unions, that portray a political strategy that is nowadays inadequate and counter-productive. It is necessary to let the principal select, evaluate and, when necessary, dismiss the personnel. Of course also the principal's work has to be evaluated, but giving him the needed tools in order to achieve results. In the absence of this needed innovation, every reference to quality will remain well apart from the actual procedures for the implementation of official requests* (principal, Italy)

The limitation of structural changes as connected to the impossibility of dismissing teachers is claimed also by Spanish principals. It has to be noticed that the role of principals in the Spanish school organization is quite peculiar when compared with the one in the other TRACES countries: the selection of headmasters is linked to their length of service as teachers and their responsibilities are not so different from those of the other teachers. As claimed by one of the principals interviewed in Israel, "*there is no continuity of what was done by the previous administration; each new administration changes what was done before*". This perception of a strong lack of coherence in policies, is another main issue raised by principals in almost all countries.

A final remark about organizational issues, concerns the procedures for the adoption of textbooks. The Brazilian case is quite peculiar: teachers are free to choose the textbook they want to adopt among some available options offered by the national government, that are the result of the systematic review of the new published books performed by a permanently established community of qualified researchers. In Colombia, the choice of textbooks happens through institutional *Bibliobancos*, available for teachers and students. The choice of texts in the *Bibliobancos* is done based on some general criteria decided by Ministry of education committees and local Secretaries of education. In Israel, science teams in each school select new textbooks among the ones advertised by publishing companies (that has already obtained the ministry of education's approval). The same criterion is used in Italy, Spain and Argentine, but no procedure of approval by the Ministry is provided.

4.5 Socio-cultural issues

The possible differentiation among kind of schools or among school experiences (conceived for different students) seems to be an interesting topic coming out of the national surveys. The interest in this issue should lead us to deal with many themes, embracing problems we are not able to unravel exhaustively in the framework of our inquiry.

Nevertheless, we would like to underline the link between this point and the wide reference to necessity of **contextualisation** in science education practice. In fact – in the answers to open-ended questions administrated in all the involved country and in the interviews with teachers and academic researchers – the idea that science has to be contextualised to everyday and/or modern situations is recurrently highlighted (*"it is necessary that science have sense for boys and girls"*).
However, if we look at all the collected answers, we notice that *"sense"* is made explicit less than it is evoked (that is the case of the Italian and Spanish surveys, for example): the main contribute to its clarification comes from Colombian and Brazilian surveys, where teachers underline the necessity of a science education promoting good integration of human activities within the environment. That is surely a theme strongly related to the presence of regional indigenous communities and the equilibrium between the transformation of their life style – on the one hand – and the impact on their live environment, on the other one. But the extent of the considerations coming from that contexts is not reducible to that topic only, while it gives suggestions on issues, which should be everywhere considered.
For example, in Brazil the state indigenous schools are considered differentiated schools. They have, in their curriculum, mother tongue and religion. These schools have indigenous and non-indigenous teachers in their staff. Students' learning is fostered, considering the pace of the students and their personnel interests for learning. The indigenous community is placed around the school and participates actively in the school planning, such as, the curriculum and school meals.
This kind of inclusive and cooperative participation of communities in school activities seems to offer interesting models of interaction between school institution and local context, which could be confronted with situations (see for example the Italian case) where teachers perceive the interaction with pupils' parents mainly as a barrier towards didactical experimentation: experimenting innovative practice, for instance the ones proposed by researchers, could in fact mean not strictly following the development of the usual curriculum and a strong pressure towards the achievement of the expected curricular results comes from the parents.
The question about what are the most adequate goals for science education is a very critical knot, which concerns the meaning itself and the articulated interpretation of "scientific literacy" and of its aims and which could open fruitful debate among involved people during the Field Actions.
For example, in the three Colombian regions where the survey was carried out, many teachers' answers referred to the role that schools have in the enrichment of everyday life. They highlighted: "the language of science gives students new ways of interpreting, and also establishing a close relationship between man and nature, in which the understanding of personal balance allows the understanding of the balance of the other beings of nature, also highlight the goodness of the application of technology in solving environmental problems. The context here is located in what is natural and in the impact of human action and the possibilities to correct or lessen this impact". Anyway, in each one of that regional areas the teaching approach seems to be focused on three different issues: person towards nature (Orinoco); ease and well-being of people (Caribbean); social conflicts, coexistence, occupational issues (Bogotá).
Therefore, explicit teachers' beliefs reveal different ways to detail the usually-mentioned relationship between science education and everyday life, with the idea that scientific

rigour could be “displaced” by interest in education for healthy living, balanced and well-being for all.
On the other hand, in other contexts the aim and the character of “scientific literacy” seems to be informed by other kinds of goals, which can be resumed (see for example the Israeli survey) as *developing the ability to make scientifically rational decisions* – with a prominence of interest in developing of skills for individual life – in contrast to *preparing productive citizens*, or *preparing future scientists* which seems to be mainly oriented by interest in developing skills useful to belonging society.

> *We develop graduates who cannot reach any intelligent decision about a scientific or technological issue, and these are tomorrow's decision makers. This ignorance leads exponentially to more ignorance, because the sectors that do not learn any science are those with the higher birth rate* (researcher, Israel)

In this perspective it should be interesting to investigate more in depth the possible contrasts between country interests, in some case expressed by policy makers (for example, in Israel someone refer to the army too) and, on the other side, the ones expressed by minorities or individuals. This is a very important theme to be explored, according to the relevance that the item “*learning how to think critically*” gets in answers to questionnaires.
Obviously, a reflection about the aims of science education involve a parallel consideration of **motivational aspects**. In fact, teachers also mention that it is very important to take into account students’ motivation, giving to it a very important role in science teaching and learning (*“the most important issue* [for science teaching] *is to share excitement about science with students”*). Some surveys (mainly the Israeli and the Colombian ones) highlight the importance of satisfaction of teachers in their job. Anyway, in each survey it is outlined that teachers are mainly satisfied at the intellectual and the relational level, and in a lower measure at the social one (in the sense of social merit of their job). Main factors of professional satisfaction are success with students' achievements, respect from students and contact with them, students' motivation and engagement, working conditions, professional interest, development and renewal. It could be very interesting to conduct a debate around this theme, making explicit the aims of teachers as leading actors in the educational processes. This is of great importance, if we assume (following the consideration of Colombian teachers) that for science education, the construction of meaning is situated in the cultural status of the teacher and is based on the type of environment that is established in the classroom, the types of relationship that fosters knowledge, the way it contributes to building identity relationships, social and emotional ties that promotes the acceptance given to the different ways of being, the coexistence of multiple views that converge in the classroom. Moreover, in this picture it became intriguing to explore if in special contexts there are teachers with special motivation, how in a sense it seems to be proposed in the Italian survey, where teachers describing a more depressed social, economical and cultural background of students than the whole sample express more attention than average to the relevance of changes in teachers selection procedures. It could be inferred a picture of teachers working in social contexts they feel as more complicated than usual,

claiming the relevance of their training background as a necessary instrument to manage those context.

In any case, here it is important to outline that the **socio-cultural composition of classes** is one of the aspects that that show a controversial profile according to teachers, being of none or bad influence for some teachers while having a positive one for others.

The Spanish (Figure 4.2) and the Argentine (Table 4.3) cases are that ones where this issue is more evident. Indeed, as regards the factors that have a neutral or bad influence on the teaching practice, *"diversity of socio-cultural levels of students"* is that one with the most articulated answer. A very interesting characteristic of Catalan schools is that they separate students according to level in much larger proportions than in other regions in Spain. This is the case even though Spanish and Catalan system are officially inclusive. However, unofficial but recognised segregation takes place often. It could be interesting to sketch a picture about this issue in each involved country and to explore beliefs and opinions of different involved actors. In Spain, for example, primary school teachers value diversity as positive despite some problems, but it is not the same for the secondary school ones. In fact, many school administrator consider that dividing students into different classroom by their abilities is not appropriate, while in the authorities' opinion, diversity of abilities is also a problem for those with higher abilities, which is not generally taken into account (but which seems to be a new priority of educational administration).

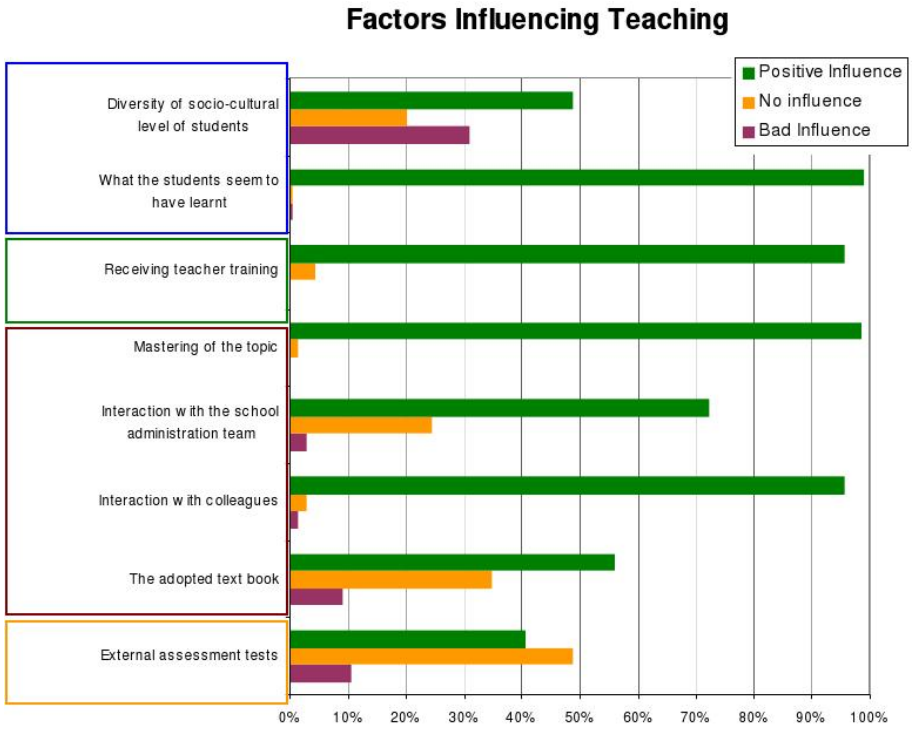

Figure 4.2 - Factors influencing in a positive, neutral or negative way the teaching and learning of science, according to teachers (from Spain survey report)

Options	Number of answers	Percentage of answers
No answer	39	8,1%
Very negatively	19	4,0%
Negatively	118	24,7%
No influence	153	32,0%
Positively	127	26,6%
Very positively	22	4,6%

Table 4.3 – Teachers' answers to question
"In what way the socio-cultural composition of class influence positively or negatively your teaching? "
(from Argentina survey report)

Generally diversity of abilities in the classroom is problematic and relates with family situations and in some teachers' opinion it entail special strategies for the management of classroom. But it seems that teachers' think to deal with this theme without a link with outsider actors.

In fact, **involvement of external actors** in the educational practice is a very few ranked option by most teachers, in particular those with more experience and who participate in research. On the contrary, it is an important factor for primary school teachers. However, when asked to comment on bad or good administrative initiatives, none of the mentioned teachers' initiatives open the school to the society. A possible explanation for this lack of interest in involving external actors is teachers' (rather widespread) perception of the value society attributes to their work.

However, the develop of critical thinking for participation in society is one of the main goal of science education, according the teachers' belief. It could be interesting to go deeper in some critical aspects, which are related to the contrast between a reference of school system to itself and what pupils' know from their experiences. Here, we want to refer not only to knowledge about specific topics (science, in our case), but also to how people learn (according their daily experiences).

In fact, teachers' disposition to carry out educational experiences in a strongly structured way conflict with the current students' access to knowledge and information, via web, in special case for what concerns the second grade secondary school

> *It's a long time I'm thinking about this. While we follow the textbook, so we follow what someone names linear learning: if one doesn't deal with the first and the second section, the third one can't be tackled, instead the students' learning is currently... how could we say? Hypertextual? For example, one can explore information about electric field, without knowing the Coulomb's law, clicking and moving from one web page to another one. So their way to learn has changed [...] I don't know what is better. At school we bring forward a linear learning that is very formal [...] But should we go on along this way? In fact the natural learning is... a little child also learns, but he does it 'clicking', that is "I don't touch the pot because I burn, I can't do out because I*

slide". Maybe natural learning is the hypertext one and we put forward an unnatural learning at school (teacher, Italy)

Here it is highlighted the necessity to re-think the teaching practice, related with teachers preparation. For example, from the Colombian survey it comes out that in the initial training programs of teachers, there is a predominance of oral transmission and rote learning of curriculum content which probably causes the same results in primary and secondary (middle school) education, the same group says that this has led teachers of science in the country most probably to have been formed with little criticism from the texts used in their formation, transmitting positivist views of science and misconceptions contained therein.
Nevertheless a picture can be outlined where the way to develop science education is strongly linked to the capacity of understanding what pupils hear or read or see (so that typical difficulties are troubles with understanding of words or texts, troubles with listening in museums, troubles with capturing the attention on showed procedures)

...we have many pupils with linguistic difficulties, Italian and not Italian ones. So, when there is an issue about Italian language, just imagine the scientific one!

... you become aware of that, when you correct the results of a test and you understand that the argument has not been caught. You try to understand why and realize that the reason is that one you couldn't imagine: they had misinterpreted the words

...moreover, as regards the matter of linguistic skills, we have also difficulties to appraise a pupil, because we are not able if his problems came from a poor linguistic knowledge or because he is limited. We understand it a little after, because sometimes the two thing are related (teachers, Italy)

In this picture, the **linguistic skills** are priority and preparatory to science education, which appears referring to a well-said. In other cases, for example for what concerns the laboratory activities in second grade secondary school, the reference is also to a well-done, understood in a procedural meaning: skills in collecting and processing data, capacity to give a formally correct report.
According to this perspective, many teachers mention the necessity to base science education activities on "practical work" and underline the importance to increase the material resources devoted to this kind of activity. Nevertheless, as a widespread attitude, laboratories are meant as a special context in which non-ordinary activities can be carried out. Moreover the typical description of lab activities given by teachers seems to present a naïve conception of laboratory activities, which is strongly based on pre-defined procedures and often lacks of the direct participation of the pupils.

4.6 Research vs. practice

In this view, the idea of good practice in science education seems to be centred around the necessity of “practical”, “experimental”, “lab” activities, which are weekly connected with an inquiry-based approach (showing a naïve meaning of hands-on work, in teachers' beliefs). In fact, experimental activities that are often reduced to the repetition of a standardized set of manipulations aimed at obtaining correct results that are not giving answer to any question. Moreover, there are very few teachers that involve structural elements of cognition into their speech (as it was noticed in the Colombian survey).
In the Spanish questionnaire – for example – the most named activity in the science classroom is experimentation, mostly from teachers holding a naive view of science learning close to that of “learning by discovery” that emphasises situations that are mostly manipulative and visual. Other teachers, however, also mention an important role of experimentation but associating it with more sophisticated views of learning, such as thus of inquiry-based learning methods or the combination of experimentation and reflection. An example of the first type of view of experimentation as the bases for science education teaching and learning is the following: the most important idea for science education teaching is that it is necessary *“to manipulate and observe in order to learn science”*. A representative quote from the more sophisticated view on the role of experimentation, for instance, mentioned *“to have curiosity, asking questions, making hypothesis, reflecting, etc.”*
Another important issue – which teachers focus on when thinking in a important idea for science teaching – is related with students’ thinking and reflection, which suggest a more cognitive view, which agrees with the fact that “students’ critical thinking” is considered by most participating teachers the goal of education. Within this cognitive view, it is emphasised giving importance to the fact that students learn to think and explain in the same way that the scientist does.
This kind of considerations are common to all contexts and all the involved country. Anyway, there are few teachers who explicitly express a relationship with thought processes that have been treated extensively by teaching approaches in research, significant knowledge or teaching for understanding.
We saw that a generalized judgement was expressed of very strong relevance for an increase of the material resources provided to schools with particular reference to the implementation of lab facilities. On the one side, such a judgement is not surprising as long as the lack of (mainly financial) resources is one the most debated issues (at societal level) about the education policies implemented in the last years (in many involved countries).
On the other side, it is interesting to focus the attention on science education and try to connect the strong request for more laboratories with teachers ideas about how lab activities could improve science teaching/learning.
In Italy, for example, some interesting issues emerged from the national questionnaire. When asked about an important idea for science teaching developed during their career, most of the teachers mentioned the use of laboratories (181 over 700 total answers) or the importance of experiments and
practical work. Putting together these three general categories the majority of the answers to the related question is covered.

The distribution of answers to the question about the source of that important idea for this sub-sample, substantially reproduces the average distribution as shown in Figure 4.3, with professional experience (in sky-blue) by far at the first place in the ranking of sources for the idea of using lab activities to better teach science[4]. A smaller number of teachers made reference to ideas (e.g. discover, reasoning, reflect) we could refer to as connected to "inquiry". This kind of answers are usually more complex than the ones in the "lab activities" category that on the contrary are often very short ("using laboratories") and in fact the intersection of the two categories covers 50 answers only. Looking at the answers to the question about *the source of the main idea in science education*, as they were given by the sub-sample "inquiry" it seems interesting to notice that the percentage of teachers mentioning training as the source of this ideas raises (to 55,2% vs. the 37,9% average of the whole sample). At the same time, teachers from this sub-sample expressed a judgement of larger relevance for changes in teacher training when answering the question about *the main idea in science education* (89,9% of strong relevance judgements vs. 83,8% in the complete sample). These
considerations reinforce the idea to further investigate through the Field Actions what teachers mean by "lab activities" and what kind of contribution those kind of activities can in their view give to science education.

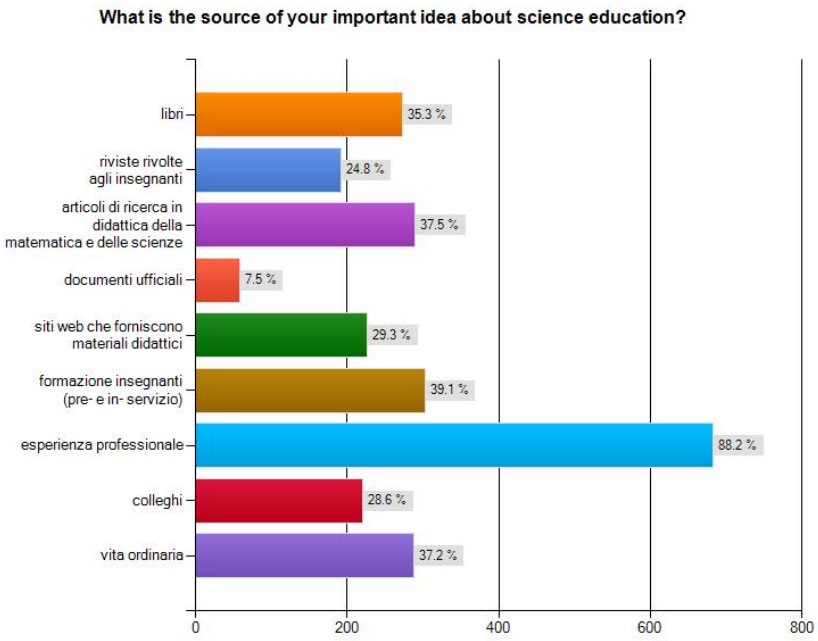

Figure 4.3 – Teachers' answers to question "What is the source of your important idea about science education?" (from Italy survey report)

In this perspective, it could be interesting to deal with teachers' ideas about relationship between educational research and practice, also trying to enlighten the relationship between the academic research in science education and the school world.

4 Please refer to the English version of the questionnaire in Appendix A for translation of the answer item. They are reported in figure 4.3 with the same order.

We can say that is common to all the considered national contexts that teachers would like to have a greater support from the university in order to improve their teaching practice.

In Brazilian survey, it was outlined (but the same goes for all partner countries) that the contact with research is neither frequent nor common, while need is felt of a stronger interaction between school and university. This agrees with the relevance of "connection between practice and research", which was given as priority to improve science education, answering to the questionnaires. In fact, also interviewed teachers considered the research a relevant transformational tool in their practice for the classroom, because it brings direct implications in the students' learning. Otherwise, it seems relevant to go deeper in outlining what kind of contribute teachers expect by that interaction.

In Israel, there were several main ideas why research in science teaching is relevant: research in order to improve teaching and learning; research in order to bring evidence to base on; research is justified only if it has influence on practice; research should originate only in schools. This ideas are present in the answers collected by other partners too.

In Spain, when discussing the more important positive aspects of participation in research, teachers highlight aspects of professional development, such as improving their teaching, learning and reflection. In other respects, when detailing the types of initiatives in which teachers' collaborate with research, most initiatives mentioned by teachers are actually no research initiatives but initiatives of science education innovation, mostly at the implementation level (more than the design one) and not necessarily innovative programs about science education in particular. In fact, three main types of participation most mentioned are related directly with innovation (non research) activities. The main type of participation is the implementation on class of innovative programs related to science education. Secondly, their participation seems to be related with other innovative programs no directly related to scientific education programs, such as environmental programs. The third mentioned collaboration refers to participation in innovation by elaborating (not only implementing) innovation themselves via design of didactic materials. Actual involvement with research activities is only mentioned in a 5% of teacher comments.

Therefore, teachers' answers refer both to issues related to the formal and content-based design of the initiative, and issues related to the support associated to them. But another important issues connected to relationship between academic and school world lies in the possibility to become aware of significant topics and developments in science education. For example in Brazil, among the teachers who considered positively experiences of cooperation with academic researchers, the majority highlighted the idea of the participation in improvement programs or in research allowing the contact with the scientific method and with the research practice. In the Brazilian report it was outlined that the contact between the teacher and the research is not frequent. This reinforces the importance of interaction between university and school for the perception of new realities, the exchange of experiences, and the construction of new knowledge. Some teachers reported that this kind of research provides the possibility of transforming and modifying the teaching practice (*"...to identify some of the problems in the actual teaching and to try to adapt this view to my classes"*).

In Argentine teachers also expect a contribute from academic research in terms of paradigmatic change in teaching and assessment, use of ICT and design of new materials.

Therefore, it seems to come out the idea of academic research producing tools addressed to use in school. As regards this view, it could be interesting to consider what was noticed in the Italian report, as an issue to be explored. A theme emerging from the answers to the questionnaire is connected to the judgement of poor relevance about the involvement of external actors expressed by the majority of the teachers in the sample. This perception is again in line with the strong relevance of professional experience as source of important idea expressed in the answers that are reported in Figure 4.3.
Moreover, expressing their view about the factors that positively (or negatively) influence their teaching, teachers mostly mentioned their training, what appears students have learnt and their skill in managing scientific topics.
Putting all these consideration together it seems we can draw a picture of teachers expressing strong confidence in their teaching skills. This argument is reinforced by the strong relevance attributed to the connection between educational research and practice as opposed to poor relevance of the involvement of external actors. This could mean that teachers would like to perform an autonomous research work in their schools or alternatively that they would like to profit, but again autonomously, from educational resources produced elsewhere by research professionals (as it explicitly appears in the Spanish survey too).
In this view, it could be interesting to understand if there are significant differences between teachers declaring themselves involved in research activities, and the other ones. At a first step, in the Italian case it is impossible to distinguish these two kinds of teachers, in the sense that no meaningful difference in the answers to questionnaire or to interviews were noticed. It is not the case in Spain, where some teachers consider their work is a form of educational research while others not. Teachers involved in research activity are highly experienced teachers (more than 10 years of teaching experience): they use more than the teacher non-participating in research a variety of educational research-based resources (including teacher magazines), but less than them direct resources for the classroom.
This reference to production and use of a specific literature is expressed in the Colombian report, where for many teachers the investigation is linked to graduate studies, to draft of thesis or papers, and to participation in groups and surveys. Innovation is related to the implementation of innovative activities, extra-classes or transversal to the curriculum. The elements that give sense to the research are the participation, the collective work, the transformation of the schools and conducting social impact activities. In most opinions no characteristics are assigned to the research task not mentioning the socialization, the choice of the population, the methodology used, the preparation of briefs or articles, and the argumentations at meetings of teachers.
In fact, the creation of communities involving teachers and university researchers it seems an interesting strategy for the improvement of relationship between research and practice in science education. In the Colombian report this point is connected with choices by policy: the relationship between research and practice is clear; as the policies involve a change in the purposes, in the content or in the procedures of teaching, they do not change the teaching practices of teachers who do not get linked to research processes. The same is noticed by Spanish teachers. According their opinion research arrives via teacher training (without, there is almost no contact). Despite it is considered

useful, it is not used because research does not arrive to schools. Making available this research is responsibility of researchers and the school administration itself.
Generally, several factors (the same ones in all the involved countries) are considered as important regarding the success of teachers' participation in research and innovation. Teachers mainly think that research should be less theoretical in order to be more effective. In addition, teachers again pointed out to the necessity of time for participation in innovation and research. Moreover, teachers refer to the necessity of training to help their participation in the innovation.
However, there are may factors that make difficult an integrate work of teachers and university researchers: for same aspects, they seem to have divergent interests or constrains:

> *Research has to bring evidences that these changes are effective but this is not easy because education is a long-term process. Action-research could be important in doing it (researchers, Spain)*
> *I already participated in the formation in CTS (Science, Technology, and Society) and applied the elements in the classroom. I considered it interesting, but the demand of a longer time is negative and we have to work with the common contents (teacher, Brazil)*

In fact, from surveys it seems come out a teachers' view of academic researchers which does not encourage the possibility of an effective common work. The academic research in science education seems to be constrained by the limited recognition and power that educational research has in the academic arena and in its policies. It appears to be oriented by the professional education of researchers and extremely focused on specific components of the teaching/learning process (being very selective about the variables to control). The peculiarity of its methodological approach tends to make them blind to other features which are instead very significant within a class (this is the opinion of some university researcher, as in the Italian case). Moreover, it is apparently unable to fulfil the expectations of the school system concerning the possible "discovery" of theories that may enable to predict learning outcomes from the application of practical algorithms in education field. Several point revealing a broad difficulty in the mutual comprehension

> *Research and school institutions do not make much effort to become engaged in a dialogue which takes time before getting satisfactory and to undertake a collaboration that is certainly very hard work for both of them. The necessary changes are all mainly connected with a radical change in the social representation of the school as a system for cultural transmission as separated from that for cultural development (researcher, Italy)*

One of the main and most widespread critical knots in the relationships between these two sides of the education system relies in the teachers' opinion about the lack of awareness of school context by academic researchers, who are often considered as only interested to data collection in school, without giving any feedback (see for example what is noticed in the Brazilian report).

The University is too far from the school and the main problem is that the University does not know the school's context (teacher, Brazil)
Research has little influence on practice because the researchers are not in the field. Those who pay for the research are not in the field and do not understand the requirements (teachers, Israel)
Every researcher at the science teaching department should be obliged to work at least part-time in school. Then they will see from inside how teaching-hours are lost and there is no equipment, and then they will see what really should be done (teacher, Israel)

Therefore, in teachers' perception the interaction with academic researchers is seen as a special and potentially fruitful partnership (as in Italian focus group it was highlighted). At the same time teachers depict researchers as lacking in the capacity to actually manage the work in the classroom, in terms of mediation strategies and awareness of contextual matters and related constraints.
While the idea of school as the place where mainly the research in science education has to be carried out come out from several directions (paying attention to several implications)

We have knowledge about many methodologies and about several proposals; however, it is difficult to put in practice, because the person who creates these rule is not in classroom and does not know its reality. This person does not know the difficulty of managing a school as there are little resources […] I do not think that the school should go to the university, but the contrary. It is necessary that the university recognizes itself as the rear of an educational vanguard which is the school (teacher, Brazil)
With a small but strong group of researcher-teachers we started insightful studies in the mathematics classrooms (especially primary school). The figure of the researcher-teacher was really important as a bridge between theory and practice. We conceptualized researcher-teachers as true members of the research team. Nevertheless, working with researcher-teachers exposes research projects to the risk of being perceived as elitist initiatives by the rest of school teachers (researcher, Italy)

At the same time, criticisms come from academic researches to teachers. In Brazil, for example, according to academic researchers' opinion science teaching continues to be developed in a transmissive and informative manner and this is a main barrier for research to be implemented. Moreover, teachers concern with concepts and experiments with no relation to everyday phenomena.
In some Spanish researcher's opinion, what research brings to teachers is mostly the idea of science for all, which is something new for them due to their disciplinary initial training. In some case, the judgement of researchers is very hard, implying a broad reflection on the entire system

Barriers to this process are various. I'll mention freedom of teaching being felt as a license to escape any assessment of teacher's work (researcher, Italy)

In this debate about the research character of teaching practice, which is a focus of our work, it seems intriguing and useful to consider an issues coming from the analysis carried out in the Colombian report, where a special attention was paid to social implication of education activity. According that analysis, participation in the research processes generates changes in the school context. One can generate work processes with the school community that can modify their conditions of a healthy environment, of caring for the natural contexts, of conflict resolution in the community, and of the conditions for production. The participation in research processes are projected to the community. Actions are generated which not only change knowledge, attitudes, behaviours of students in the school but also in their context and then radiate these actions to their closer communities.

4.7 Gender related issues

As evidenced by a wide literature[5], gender difference does play a role in individual and societal attitudes towards science and science teaching/learning. Women are largely underrepresented in science careers and stereotypes abound in public perception. Perception of self with regards to science and science learning is also often gender related, with boys usually overestimating their competences and abilities and girls underestimating theirs. On the other side, research claims that difference in attitudes and performance in science learning are not related to a lack of interest in the girls, suggesting that the way science is portrayed by the media and presented at school is somehow gender biased. Teachers themselves explicitly or implicitly transmit societal or individual beliefs in that regard to their students. In any case, teachers' beliefs as regards gender difference influences the way they relate to their students and informs their practice in the classroom.

TRACES' surveys addressed the problem with three specific questions[6] included in the teacher questionnaire in all partner countries[7]. We asked teachers if they experience differences of interests in boys and girls towards different scientific themes (Question 13) or engagement in different types of activities (Question 14). We know, for example, from research that girls are more sensitive to those aspects of science that are related to societal issues, such as the preservation of ecosystems or health care. We also know that girls are usually more engaged by activities that involve communication and interaction with peers. We have also asked our sample teacher populations if they take any difference into account when they plan their activities in the classroom or if they revise their practice according to emerging differences (Question 12).

As we expected, a general result is that the issue is generally underestimated by the majority of teachers questioned. Most of respondents say that they don't notice

[5] See for example Sjoberg (2005), Jacobs (2002), Koke (2005), Duschl (2007).

[6] See questions 12-14 in the Common teacher questionnaire for the national surveys, Appendix A.

[7] With the exception of Spain.

difference among their male and female students and their comments suggest that taking difference into account is perceived as a kind of discrimination. The attitude perceived as "correct" seems to be treating all students as they were the same, the classroom as a whole, as if this would preserve equity.

On the other hand however, there is a significant number of comments, in which respondents do note that "I actually didn't think about this issue in this terms" and claim they should do more so.

Another interesting result is that, although the general trend is common to all partner countries, there are significant differences in proportions among them. These differences are consistent to those emerging from other international studies, especially the ROSE study, where they are correlated with the level of economic development of the country.

In Italy, we found the largest percentages of respondents claiming that they don't notice differences between their male and female students for what regards science learning. As shown in the following charts, the percentages of teachers answering negatively are all well above 80%.

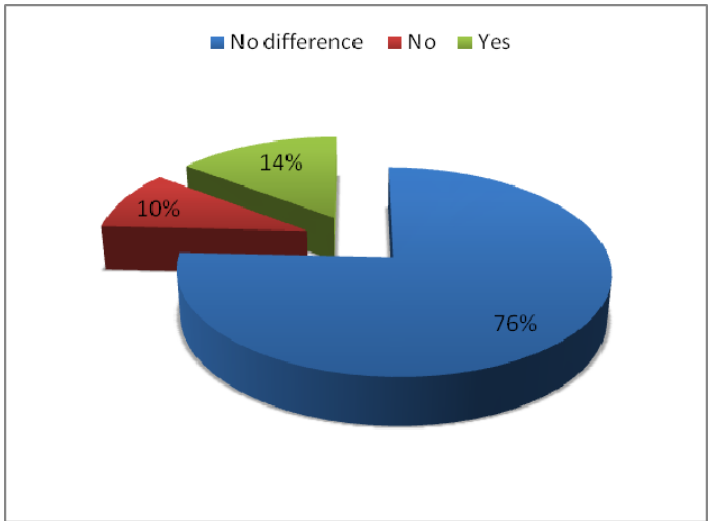

Figure 4.4 – Answers to Question 12 – Italian survey

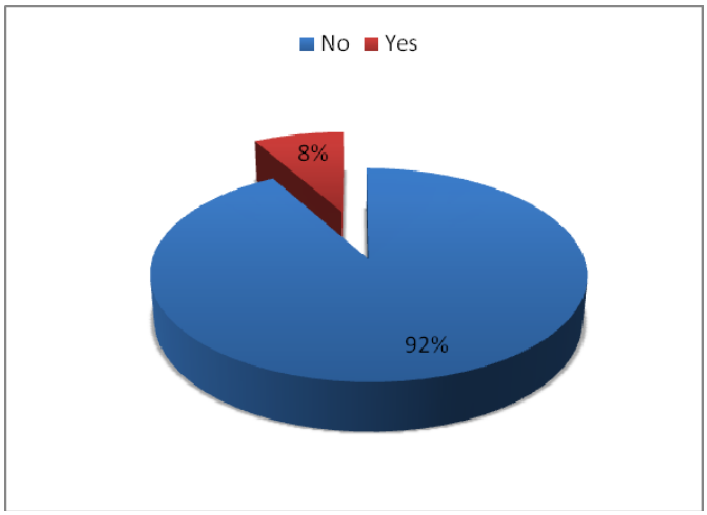

Figure 4.5 – Answers to Question 13 – Italian survey

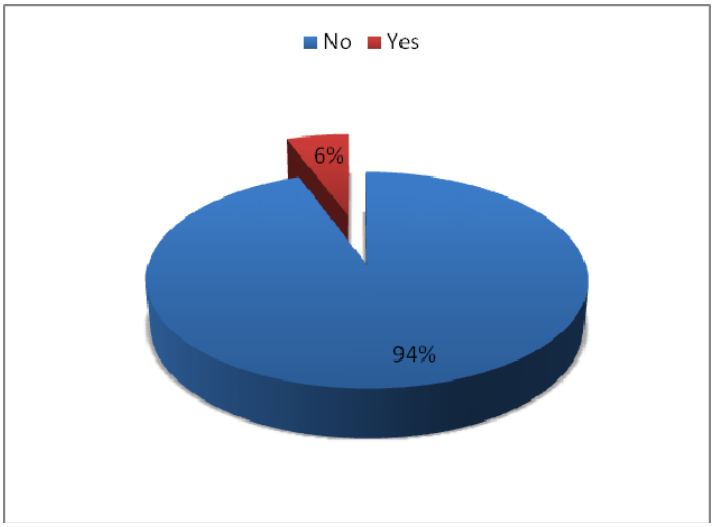

Figure 4.6 – Answers to Question 14 – Italian survey

When confronting these findings with those in the other partner countries one sees that the sensibility the highest sensibility to the subject is found in Israel and Brazil while Colombian results are somewhere in between.

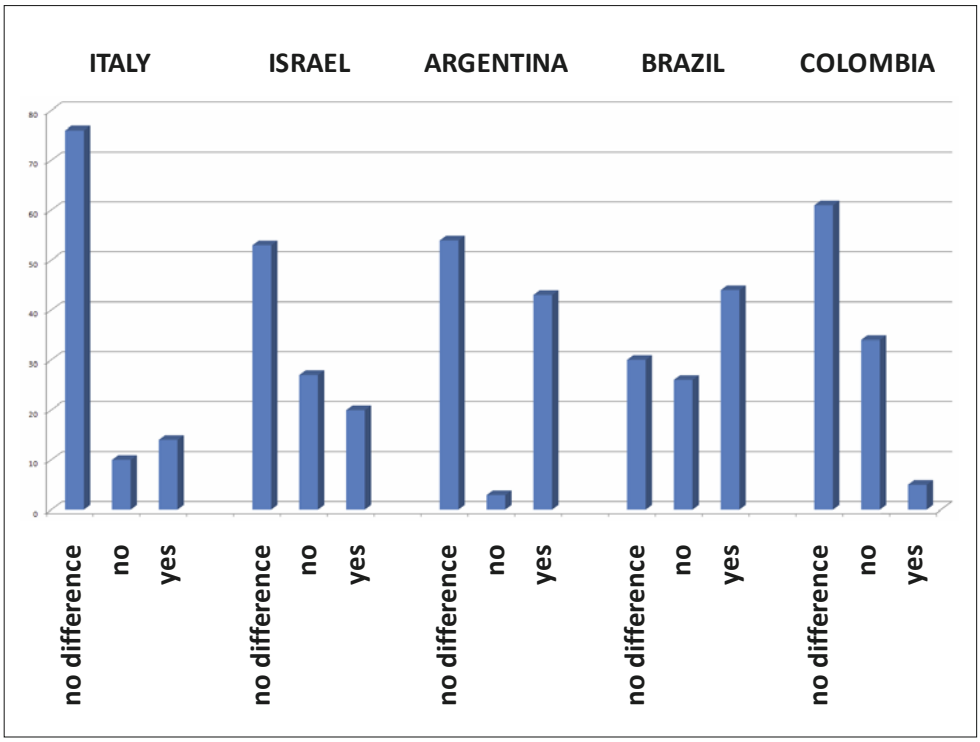

Figure 4.7 – Comparison of answers to Question 12

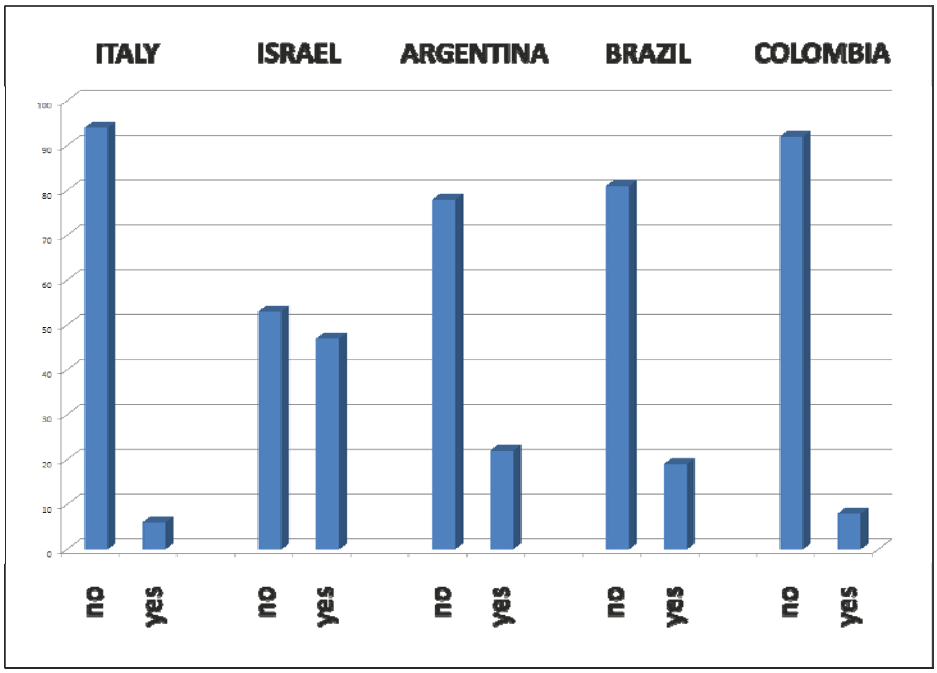

Figure 4.8 – Comparison of answers to Question 14

Resonating with research literature, we also found that teacher mention a number of subjects such as sexual education or environmental issues as more popular among the girls and astronomy or electricity more popular among boys. Many teachers also mention communication as an activity in which the girls engage more willingly than boys do.

Teachers' beliefs with regards to gender related issues as emerging from TRACES surveys seem to represent another element of distance between research and practice. Whereas research recognizes gender as an important factor influencing students attitudes and perceptions with regard to science and science learning, teacher seem to underestimate its significance and neglect it in school practice. We believe this is a subject to be addressed in our upcoming field actions.

5. Criteria for the field action

TRACES field actions will be carried out over a period of 15 months, form January 2011 until March 2012, following a timetable composed of four main stages:

1. During January 2011, some regional workshops will be organized in each partner country. The workshops will involve all the teachers and principals involved in the project together with representatives of the local school authorities. The aim of these workshops is to share with all the participants the results of the national surveys (TRACES Deliverables D2.1-D2.6) and the indications for the field actions contained in this report, discussing their cultural and educational implications.

2. The following two months will be devoted to the construction of project workgroups in all the involved schools (possibly including teachers, principals, technical personnel and pupils' parents together with the TRACES researchers) and to start their activities. The first task for the workgroups will be a systematic revision of the research materials already discussed in the national workshops aimed at informing the design of the didactic activities. The general timetable for the development of the activities will also be designed.

3. The realization of the actions will cover a period of about ten months (March-December 2012), which will allow for evaluations on the short-, mid- and long-term. During this period, partners will share their observations in progress, in order to share findings and monitor the project development.

4. The last three months (January-March 2012) will be devoted to the analysis of the documentation and evaluation materials collected during the actions with the aim of producing case studies describing the entire design and carrying out process.

The design and implementation of the field actions will be informed by the following general criteria:

- The classroom activities will be never based on pre-defined recipes and procedures nor on the implementation and use of pre-designed didactic materials.
- Teachers and university researchers will share the design of actions.
- Possible specific topics for the actions will be selected coherently with local curricular needs.
- Special attention will be paid to understand what is the influence on the design and implementation of the activities, by the structural aspects characterizing the entire school system and each single school as a whole.
- Special attention will be paid to the cultural dimension of the teaching/learning processes.
- Teachers from all the involved countries will have the opportunity to interact with their colleagues, at the national and consortium scale, through the project web portal.

5.1 Indications coming from the cross-comparison of the national survey

The cross-compared analysis of the TRACES national surveys (Deliverables D2.1-D2.6) suggested a number of indications for the implementation of the field actions. These indications are briefly summarized in the following lines.

a) Distance between official guidelines and actual teaching practice

The TRACES surveys confirmed the existence of a wide separation between the aims of national policies and their impact on the actual work of science teachers in the classrooms. Among the reasons for this separation we identified, there are the lack of involvement of teachers in the design and evaluation of policies, the weak connection between official guidelines and the actual teaching/learning contexts, the lack of knowledge of the guidelines by teachers also in connection with the lack of relevant teacher training initiatives, teachers inertia towards didactical experimentation.

Classroom activities in the field action should be based on what teachers actually do in their ordinary work, placing it in a wider framework, referring to epistemological, disciplinary and cognitive aspects. Teachers should be directly involved in the design, implementation and evaluation of these activities.

b) Relationship between school teachers and external actors

Teachers often look for support outside of the school. The academic world is perceived as poorly caring of school needs. The intervention of “external experts” in school activities brings an important and necessary contribution in terms of disciplinary contents, but is concurrently lacking sensibility concerning the dynamics of relations and work with children. Actually, the interaction with the “outside” can be interesting and useful, but too frequently the fact happens that the external activities completely substitute the regular science curriculum, because of a lack in programming and design educational paths to be in case integrated with those experiences.

During the field actions, we will pay attention to observe the impact that shared programming can have on the quality of the interaction between teachers and external actors.

c) Impact of assessment methods on science teaching

The introduction of standardized procedures for the assessment of learning is quite generally perceived by teachers as a negative innovation as long as these kind of tools expose to the risk of shifting the focus of teaching/learning towards the achievement of good results in the tests.

The TRACES classroom activities will be designed in a general framework of reflections about the close relationship between the intended objectives of the activities and the use of evaluation criteria and tools that are adequate to assess those objectives.

d) Teaching practice as a research work

Teachers are used to attribute strong relevance to the connection between educational research and their teaching practice, while they poorly consider the interaction with

external actors. This perceptions seem to suggest that teachers would like to perform an autonomous research work in their schools or alternatively that they would like to profit, but again autonomously, from educational resources produced elsewhere by research professionals.

The field action will be focused on a process of reflection shared between teachers and researchers about the kind of contributions that educational research (and researchers) can give to science teaching in schools

e) Interactions among teachers

Collaboration among teachers and sharing of competencies and ideas are considered as founding values of their work and as important resources by many teachers. Strong relevance is attributed to training among peers that is considered as an important occasions to improve each other's knowledge. More in general, appreciation is expressed by teachers towards the construction of networks of collaboration at different scales.

Attention should be paid at the modalities of interaction among teachers. Models for peer-to-peer exchange of competencies should be designed, experimented and discussed all along the field actions.

f) Role of experimental activities in science teaching

Many teachers underline the necessity to base science education activities on "practical work" and the importance to increase the material resources devoted to this kind of activities. Nevertheless, the typical description of lab activities given by the teachers seems to present a naïve conception of laboratory activities, which is strongly based on pre-defined procedures and often lacks of the direct participation of the pupils.

During the field actions we will stimulate reflection about the nature of experimental activities and the role of "inquiry" in science education. Laboratories should be conceived as the context in which educational paths and their evaluation are constructed and not simply a support to the curriculum that cannot be renounced. Discussing with teachers about the evaluation of the lab activities and its role in the overall evaluation of learning should be a central issue in the design of the field actions.

g) Teachers' self-perception of the adequateness of own preparation (training)

All the national surveys bring to evidence teachers' general need for more specific training in order to be able to manage the contents in science curricula. The perceived inadequacy of preparation often leads to a difficulty in acknowledging the official requests because they are badly understood and hardly translated into practice. Teachers often refer to their own professional experience as the main instrument that allows them to manage their work in the classroom.

During the field actions attention will be paid to discuss the impact that the actual pre- and in-service training of the involved teachers have on their practice, aiming at better understanding in what sense it can be a barrier or a resource for science teaching.

h) Gender related issues

The picture emerging from the TRACES surveys shows that teachers usually attribute poor relevance to gender issues in terms of the impact they have on their teaching practice. Nevertheless, differences in perceptions emerged in some of the partner countries. As researchers, we know how much literature is devoted to analyse this specific cultural dimension of teaching and learning.

During the field actions, particular attention should be paid in reflecting together with the teachers about this issue, stimulating sharing of experiences among teachers from different countries.

i) Impact of structural constraints on science teaching

Another main issue emerging from the surveys is connected to structural barriers towards the improvement of science education. Among these barriers are the organization of teachers' work (mainly in terms of timetables), the lack of material resources and in some cases the interaction with the school administrators. At the same time, actual communication among teachers is often limited to the resolution of organizational problems and the institutional opportunities for dialogue usually maintain this kind of poorly significant interaction.

During the field actions attention should be paid to document the actual impact of structural issues on the design and implementation of classroom activities. In particular, the interaction of teachers with school administrators is another point on which attention has to be focused, confronting teachers' perception about structural issue with the one expressed by principals.

j) Role of the contextual dimension in science teaching

In teachers' perceptions the interaction with science education researchers is worsened by their lack of awareness of contextual matters and related constraints. At the same time, teachers also complain about the wide separation between the requests of official documents in terms of contents to be taught and the actual learning needs that characterize the social and cultural contexts in which they operate.

The field actions should be designed and implemented always keeping in mind the strong connection between disciplinary contents and contextual dimension, which should be considered as two equally important faces of the educational activity.

5.2 Structure

The actions of project workgroups in each core school will start with meetings devoted to design and to schedule the activities for the following ten months. Then the workgroups will share the course of action and the specific topics to be possibly covered in the activities. A first operative phase could comprise short training interventions addressed to all teachers in the school (and designed coherently with the previous decisions), in parallel with the starting of the classroom activities, which will be collaboratively conducted by university researchers and teachers.

Long run, the activity of the project workgroups will develop as an action-research; the activities autonomously carried out by teachers will take turns with meetings devoted to discussion and reflection on the actions and, in case, to modify the initial program.
The international network of researchers involved in the project will make connection among the experiences conducted at the national level, providing a continuous sharing of locally developed ideas, models, solutions, and strategies. Therefore the work in each context will be enriched by what happens in the other ones.
The documentation and the evaluation of all these activities will be the starting point for the development of a number of case studies, which will represent the final result of the field actions.
Each case study can concern the work of a single teacher, groups of teachers, an entire school or networks of schools. The choice of the scale for each case study will be left to the local project workgroups, according to the contextual conditions (presence of networks of schools, inter-disciplinary project in a school with several teachers involved, single classes that are particularly interesting for their social composition, etc.)
Regardless of these differences, all the case studies carried out in each involved country will share the attention paid to several relevant aspects, useful to consider the schools in a systemic view:

1. how the structural and organizational features of the school (e.g. material resources, curriculum, official indications, managing of teachers' work) can promote or prevent the carrying out of certain teaching/learning strategies;
2. how the structural and organizational features of the school can promote or prevent the exploitation of specific potentialities (e.g. the possible sharing of experiences among teachers);
3. how the relationships between teachers and university researchers affect the design and implementation of a pedagogic path;
4. how the relationships among teachers (in a single school or in a network of schools) affect the design and implementation of a pedagogic path;
5. how cultural diversities in the schools affect the educational practice (e.g. referring to teaching and learning styles, to gender differences, to role of language in teaching/learning processes, to self-perceptions in the socio-economics context).

The local contexts will be structured in a reticular form (school-school, local authorities, universities, museums, etc.) with the possibility to transform the “local system” in “learning community”, allowing the interaction of all the involved actors for the sharing of experiences and knowledge.

5.3 Realization

The proposed work-plan stems from the idea that regardless of the particular context in which it is implemented, educational practice has to be intended as a research activity. This means it has to be developed according to a reference frame that gives an actual meaning to the operative choices taken. Therefore, we want to design our actions on a long-term basis, defining the pathways through which they will be developed. Such a

strategy, should also help us interpreting the contributions to the classroom activities coming from the students and, consequently, should address teachers in managing those activities in their everyday practice.

Such a reference frame should consist of explicit and aware assumptions about different aspects of the educational practice in schools.
In particular, we think we have to clarify:
- what kind of students' cognitive dynamics we think are implied in our activities;
- what kind of lenses we use to look at things in a scientific perspective;
- what disciplinary aspects we assume as relevant for the cultural growth of students;
- how the idea of scientific culture we are portraying is rooted in the cultural context in which the activity is carried out.
By its own nature, this reference frame could and should be reviewed taking into account its actual impact on the work we are carrying out in the classrooms.

Our work-plan consist of a collaborative research involving both the school component (mainly made of teachers) and the university component in project workgroups. Each of the components contributes with its own specific tasks according to the following general scheme:

University component
- Starting from a shared reflection on the ordinary work of teachers, stimulate the construction and contribute to the elaboration of the reference frame of each project workgroup (mediating open discussions; introducing hints for reflection; sharing literature references)
- Contribute to the design and implementation of the classroom activities
- Coordinate the documentation and analysis of the entire process of development the project activities (analysing materials produced in the classroom; analysing audio and video recordings of activities; producing reports to be shared with the workgroup; stimulating shared reflection about decisions made, difficulties encountered, possible improvements)
- Stimulate the sharing of experience towards wider communities (other workgroups in the same country and at the consortium level, local networks of schools, local authorities, academic community)

School component
- Allowing the construction of the project workgroup in each core school (involving a significant number of teachers actively participating in the workgroup activities)
- Contribute to the elaboration of the reference frame of each project workgroup
- Contribute to the design and implementation of the classroom activities (with particular reference to their transfer into the ordinary work)
- Contribute to the analysis of the entire process of development the project activities (participating in observations and discussions; producing reports)
- Share experiences towards wider communities (other teachers in the same school, other workgroups developing similar activities, other stakeholders involved in the project networking activities)

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Appendix A: Common teacher questionnaire for the national surveys

1. Think of an important idea for science teaching you have learnt in your professional life: what is the idea?

   Where/how did you learn it? (one or more options)
   a. book
   b. magazines
   c. articles
   d. documents
   e. websites
   f. teacher training
   g. experience
   h. colleagues
   i. normal life

2. Rank in order of importance the following 3 objectives for science education:

   a. Science education for becoming a scientist
   b. Science education for critical thinking
   c. Science education for participation in society (science for all)

   Please comment

   How many of your colleagues do you think agree with your answer?
   □ few □ a good part □ the most □ almost all

3. How much does the interaction with colleagues in your school affect your educational practice? (Likert: useless; marginal; relevant; necessary)

4. How much do you think you contribute to the educational practice of colleagues in your school? (Likert: useless; marginal; relevant; necessary)

5. Do you think there have been good or bad national initiatives on science education in the last 5 years? Which?

6. In what way each of the following factors influence positively or negatively your teaching? (Likert: very badly, badly, no influence, positively, very positively)
   a) Text book,
   b) Interaction with colleagues
   c) Interaction with the principal
   d) Form of assessment test
   e) Contributions made from your training
   f) What the students seem to have learnt
   g) Mastering of the topic
   h) Socio-cultural level of students
   i) Others you consider

7. Have you participated in any programme, innovation, contact with research, etc…
   - What was positive about this experience? Please describe in what sense it was positive (ex. For teachers, students,….)
   - What was negative about this experience? Please describe.

8. In order to improve teaching and learning of science at school, do you think the following actions are:

(Likert: useless; marginal; relevant; necessary)

a) changing official requests
b) increasing (material and financial) resources for schools
c) changing the way teachers are trained (pre- and in-service) and selected
d) reorganizing teachers' work
e) involving external actors (not schools) in the educational practice
f) changing the criteria to assess learning
g) interchange ideas with other colleagues about the successful or unsuccessful actions in the classes
h) built up special laboratories
i) make secure connection to Internet
j) development of new didactic materials
k) link the practice with the results of educational research
l) Other (as many items as you like)

How many of your colleagues do you think would agree with your answer?

□ few □ a good part □ the most □ almost all

9. When you are not satisfied about some of your teaching, where do you look for ideas to improve your practice? (one or more options)
    a. book
    b. magazines
    c. articles
    d. documents
    e. websites
    f. teacher training
    g. experience
    h. colleagues
    i. normal life

10. Is your professional life satisfactory (Likert: 4 grades to be specified)
    - From an intellectual point of view?
    - From a personal point of view?
    - From a social point of view?

    If yes, where does this satisfaction come from? (give examples)

    If not, what would be necessary to change the situation?

11. What do you think your students would remember as a particularly good learning experience from your classrooms?
12. If you should observe that a particular classroom activity has engaged boys more than girls (or vice versa), do you consider to have to design a new activity on the same subject, in order to engage the other group more?

    Yes No In general, I don't observe such differences

13. When you think about which themes to exploit in order to stir pupils' interest, do you consider that some might work with boys better than girls or vice versa? Could you give some examples?

14. Do you think that the way a particular activity is carried out (for example as group or individual) might engage boys more than girls or vice versa?

    Yes No

    Please comment

Appendix B: Information provided by the partners to integrate the national reports

a) Documents sent by the partners during Month 6

General issues for cross-comparison - Brazil

1. Relationship between official guidelines and requests and science education practice

The official guidelines for scientific education in Brazil are defined in the *Parâmetros Curriculares Nacionais* (PCNs), developed in 1998. These documents display a proposal for teaching and for learning based on the development of skills and of minimum expected competencies and consolidated through structural issues. It presents a conception of students as active subjects in the process of learning and as subjects integrated with the reality of a technological society.

However, just a few teachers have familiarity and mastership of the guidelines. The researchers verified that many schools and professors evaluate the guidelines under a perspective of discredit and indifference. They attribute these manifestations to the fact that the material has been produced without an open debate about its contents and theoretical background. Despite the resistance observed in other studies, the PCNs influence the pedagogical practices of teachers.

At large, the practice adopted in schools is still predominantly traditional, based on the reproduction of scientific knowledge in an uncritical and fragmented manner. Few empirical activities are developed. Science education is unrelated to everyday life.

Few are the teachers who use the previous knowledge of the students as a starting point for the discussions of the themes under consideration. The students' interest for the science happens through emerging themes and through the themes conveyed by the media. Some changes in this scenario can be observed when the teacher is challenged to reflect upon his/her practice in the classroom by ongoing formation or in the Graduate Courses.

Lately, the cross-cutting themes to the subject matters have been deepen discussed, increasing the incidence of interdisciplinary approaches. These approaches often lead to a search of new information and, occasionally, to an approximation to research.

The educational policies do not establish relationship rules between University researchers and Basic Education teachers. They encourage such practice and highlight the importance of educational research.

In-service teacher education programs have been employed in Rio Grande do Sul state. In 2009, with the proposal called *Lições do Rio Grande*, the state presented methodological suggestions for general education which involved the collaboration of researchers and experts in all fields, including Science Education. Especially for political issues and possible directions, this program was just accepted by a few teachers.

The greater number of the teachers applies the textbook as major teaching resource. The application of the textbook in the school is done by teachers' choice among some available options offered by national government.

The evaluation procedure in the classroom is under teacher's criteria: writing tests, individual or group work, participation, attitude, self-evaluation, among other issues.

The federal and state evaluations are not mandatory. Nevertheless, these evaluations influence the teachers' choices, once they intend to take the evaluations as a reference concerning the contents being taught. In Science field, there is no federal or state exam. According to PISA 2009 exam, Brazil is in the 53rd position in the OCDE countries ranking.

2. Relationship between research and practice / teacher training

Basic Education in Brazil is organized into two stages. Elementary School (which lasts 9 years) begins at the age of six and it is mandatory. High School lasts 3 years, it begins at the age of fifteen and it is not mandatory

To be a teacher in the first grades of Elementary School (from first to fifth grades), it is just requested a High School primary teaching course. To be a teacher in the final grades of Elementary School, it is requested a degree. There are specific Undergraduate courses for High School teachers in the fields of Physics, Chemistry, and Biology. In the final grades of Elementary School (from sixth to ninth grades), the Science content is called Physical and Biological Sciences and, at large, it is taught by teachers with degree in Biology.

There is a great shortage of teachers in Science teaching. Thus, it is common to find teachers without a degree or with an undergraduate degree in another field working in the Science teaching in schools.

The teachers' ongoing formation is fostered by school managers and principals. The initiative and the resources come from various levels of government (federal, state, and municipal). A great part of the teachers support the proposals. The ongoing formation, unfortunately, is restricted to a small group of teachers due to the necessity of the absence of the teacher from the school and the absence of a substitute teacher. In general, the teachers do not dispose of schedule reserved for study, just for planning, which absorbs approximately 20 percent of the schedule in the classroom. The teachers would like to have a greater support from the University in order to improve their teaching practice.

The interviewed teachers report that the contact with research is not often and recognize the need of a stronger interaction between school and University. They considered the research a relevant transformational tool in their practice for the classroom, for it brings direct implications in the students' learning. However, there is the necessity of extra time, of physical space, and of financial investment. There are few teachers who have access to these resources.

3. Interaction among teachers

The interaction among teachers in the schools is not structured, depending on the opportunity given by the school principal, by pedagogical projects, and by individual initiatives.

The answers to the questionnaires demonstrate that a great part of the teachers perceives the interaction among colleagues as fundamental. Such importance is highlighted especially in interdisciplinary approaches and among colleagues who share the same concern on the student learning issue. In general, schools that develop interdisciplinary projects present a higher predisposition to teamwork. The exchange of teachers' well successful experiences in school is considered as an action that can improve Science teaching. The teachers emphasize the importance of collaborative work with colleagues who share the same concerns. The activities of physical on-site presence or at distance learning have provided a networking and closer approximation, despite its virtually for teachers, particularly for those who are already making systematic use of the computer.

A smaller group of teachers consider the interaction with peers as irrelevant to their practice. They emphasize the lack of motivation and the pessimism of colleagues in relation to education and innovations in the classroom; besides, they report the lack of opportunity and of extra time for discussion and planning meetings with colleagues.

The teachers' action is considered as lonely and dependent on individual motivation. The teachers reveal no impediments to the development of innovative proposals coming from the principal and the administration of the school. The reduced amount of hours dedicated to joint planning and the overload of hours in the classroom for the teacher raise difficulties for a greater interaction among teachers.

4. School administration/Lack of resources

Rio Grande do Sul state had, in 2009, 7,812 schools, 1,794,252 students, and 103,313 teachers in the public schools. The average class size is thirty students. Most schools have Internet access. There is support in the administrative bodies for the use of informatics resources, but the equipment and qualified and enough personnel is still insufficient.

The school principal has a major role as an organizer, as an integrator of school teachers and as a linking element with the administrative levels of government. It is observed that, in general, the schools that achieve better results and apply innovative practices have principals who are part of the

teachers' team and of the latter with the school community. The heads of departments by field of knowledge in schools do not have a central role in the teaching practices.

5. Socio-cultural issues

The state indigenous schools are considered differentiated schools. They have, in their curriculum, mother tongue and religion. These schools have indigenous and non-indigenous teachers in their staff. Students' learning is fostered, considering the pace of the students and their personnel interests for learning. The indigenous community is placed around the school and participates actively in the school planning, such as, the curriculum and school meals.

Regarding to the gender issues, it was found that the great part of the teachers points out variations in pace, in performance, and in interest, depending on the topic to be focused. However, most of the teachers states that do not develop different courses planning for boys and girls.

6. Best practice

In Brazil, there is a great separation between researchers and Science teachers. This process has not gained further advance, nor seen as necessary. One of the main obstacles to the approximation between both is the resistance to change by teachers, who keep a teaching manner mostly transmissive. On the other hand, the researchers share the main perspective that research is done *about* teachers and the school, instead of *with* teachers and inside the school.

Structural obstacles are also considerable, such as excessive working hours, the lack of time for ongoing formation, and a point of view of teaching as transmission of knowledge by the educational authorities, parents, students, and society in general.

In spite of that, there are many innovative experiences and works in schools and in institutions of higher education. In particular, the field of research in Science education in Brazil is distinguished by the quality and quantity of conferences, publications, and Graduate courses.

Two interactional programs between school and research are highlighted. The first one conducts training teachers from across the country into the schools as learners. In the program, academic professors, school teachers, and training teachers constitute a working team toward innovation in teaching and improvement in learning. Every team is bestowed support (time and money) to put into action the planned actions.

The second, statewide, is the program of visits to the Museum of Science and Technology of PUCRS. In the program, public school students receive a guided tour. For this purpose, the teachers from these schools take part in workshops that seek a more constructive interaction with the experiential dimension of science. This program is a recent one; therefore, its scope is restricted and its results are partial.

These programs are considered positive, but there are still many obstacles for its application and extension to the schools. Mainly, there is a lack of involvement of colleagues, a lack of time in the working hours, a lack of infrastructure in most schools, an excessive numbers of students in the classroom, and a lack of technical support in science laboratories.

As a result, it is difficult to develop classroom activities related to research and to its results and discoveries. There is also a lack of motivation for the lowered social and economic valorization of the occupation, leading to a disinterest on the part of teachers in improving their teaching practice.

General issues for cross-comparison - Colombia

1. Relationship between official guidelines and requests and science education practice

The educational policies and the science and technology policies in Colombia are not distant from international policies. They obey the economical and political trends of the global markets and also the political and administrative directions that nations take for periods of government development. In Colombia, these parts are basically determined by the political platforms, which are chosen in electoral periods defined by the Colombian constitution. These roads establish a direction for the country regarding public policies, development plans, action strategies and other aspects that can achieve dynamism in such platforms in the periods of time that were set. It is not surprising that

policies in different areas or sectors are related, have common goals and impact directly or indirectly the various fields of society. The definition of educational policies is determined by the economic policies, and in turn these policies generate effects in other sectors.

A first aspect worth noting from the study is that in most reviewed documents the role of international and intergovernmental entity policies are highlighted in the way that public policy is assumed on education, science and technology in Colombia. These views are not aseptic, they have direct intentions in science and technology policy in Latin American countries through organizations like the United Nations, UNESCO, OAS, IDRC, IDB and others in recent years have been insisting on regarding the application of science and technology to developmental problems with clear goals around managing and promoting the development of institutional structures as well as a scientific and technological interests in generating transnational and intergovernmental new knowledge in the countries of Latin America, or use the existing one on the analysis of economic and social problems of each country.

These policies transcend the decade because since the sixties they have set the standard for science and technology policy and education policy in the country, this is why in the decades of the sixties and seventies the groundwork for the creation of the Colombian Research and Special Projects "*Francisco José de Caldas", Colciencias*, and the National Council of Science and Technology were set as a consultative and advisor organism of the National Government with regard to scientific and technological policy. It is also during this period that the *ICETEX (Instituto Colombiano de Crédito Educativo*) was created.

In the opinion study, there are frequent references of the teachers interviewed referred to in the 1991 Constitution concerning the right to education of every boy and girl, taking education as a social function by allowing the search and access to knowledge, to science, to technology, and other property-values of culture. Somehow in many of the explanations of teachers it is assumed that education contributes to the cultural acquisition, scientific, technological and environmental protection. It should be noted that do to the political constitution of 1991, teachers in general, and especially those in the regions make further reference and assume central tenet of the charter in regard to education as manager of training and environment on the right that all people have to enjoy a healthy environment, as well as the legal guarantees of participation in decisions that may affect them, protect the diversity and integrity of the environment and conserve areas of special ecological importance, are recurring themes in the dialogues of the teacher especially in the regions examined.

In addition to the constitution of 91 the approach is referred to in the General Education Law of 1994, "Education should promote the full development of the learners' personality, giving access to culture, the achievement of scientific and technical knowledge and training ethical, aesthetic, moral, and religious citizens, to provide the realization of a useful activity for socio-economic development "Article 92 (Act 115, 1994). Many of the teachers interviewed implicitly or explicitly recognized science education as an important element in the development of the nation.

Science teachers somehow assume in their narratives the purposes of science education as envisaged in the General Education Law (Article 5, paragraphs 5, 7, 9, 10 and 12) it is important that teachers, in some way or another, relate to the need to develop intellectual habits, to acquire advanced technical knowledge among others, as a condition of development of knowledge in school, referring to the access of boys and girls to knowledge, science, technical and other property-values of knowledge in which research and artistic creation is a fundamental element of the different forms of classroom expressions, are denoted on the development of critical, reflective and analytical thinking, of boys and girls as a condition for strengthening the scientific and technological progress of the country and this in turn relates to the idea that is also referred to in the same numeral, to prioritize the improvement of culture and quality of life in pursuit of social and cultural development.

In this same sense the enunciation are frequent the guidelines in general and in particular for teaching of sciences that over the last decade guided the formulation of the Institutional Education Project (PEI) and classroom activities where the generation of Standards of Basic Competitive Skills to guide the

educational process in the pursuit of what has been Called “quality education”, in this route the programs of COLCIENCIAS like ONDAS stands out nationwide.

The thing you might notice is that in general the policy of the past 10 years in Colombia has not changed its central position towards science and how to teach it, one way or another it gets closer to ideas of coverage, quality efficiency, decentralization and development of epistemological positions, it is possible that between the two educational policy around science or science and technology policy prevail rationalist and positivist looks, and historicist and culturalist glances will be less frequent.

That can be analyzed is that the shift of century and the traffic in the last decade confirms a number of challenges, not only for Colombia but for Latin America, about what has been raised as human-scale development. With regard to education policy and science education, it’s clear that major policy guidelines directly involve educational contexts posing challenges that are in some cases exceeded in previous periods. In the case of Colombia, and in accordance with the Millennium goals of the last decade, it is evident that the system of education should consolidated in the ability to create citizens that are aware of their cultural identity while having relationship with the world as is expressed on the national and universal goals determined in the 8 millennium development goals and objectives.

Despite the slight economic improvement of recent years in Latin America and in other rough regions, including parts of Europe and North America, the levels of poverty, indigence, unequal income distribution that leads to social fragmentation, cultural exclusion, violence and social injustice persists. There also exists, and derived from the previous situation, in Latin American and in other countries inequalities that have to do with to knowledge, achievement, learning outcomes and educational quality. Within this inequality the access to scientific knowledge and scientific culture stands, as a basis for civic education aimed at making justified and responsible decision, and with the commitment to build a sustainable future.

One of the indicators of development in which Colombia is not doing well is that of education, as the World Bank data indicates that public spending per student has not risen, but retracted. In 1999 15.2 percent of GDP was destined for primary education, per capita, 16.1 percent for middle school, and 37.8 percent for university. Nine years later these percentages are lower: 12.4, 14.8 and 26, respectively. In total, public expenditure on education was 3.9 percent of the GDP in 2008, slightly above 3.6 percent in Latin America, but less than 4.6 percent that is destined worldwide. However, Colombia stands out because it has all elementary school teachers with professional training and one hundred percent coverage of primary education among the population that is old enough to study in this level.

In the recognition of policies and initiatives, the teacher is assumed to be the protagonist of the discourse that questions the way they understand teaching practices. In this condition the teacher supports initiatives that promote new ways of relating and living recognizing as important the solution that are felt by the community and that creates linkages between the different actors of the schools.

Also, the teacher assumes the involvement of certain policies or initiatives in their practice as they change the ways in which he believes his work should be carried out, assumed to be negative policies that do not take into account cultural differences and establish homogenization criteria to teaching practice that leads to the assumption that teachers need to make distinctions in the way they deal with science education in different communities.

The ignorance of the reality that surrounds and flows through educational institutions would say that teachers know and interpret their social environment that are sometimes not taken into account in defining policies, establishing a gap between them and social realities; an aspect worth noting as an opportunity to bridge the gap between official requirements and teaching practices. Teachers can be 6 spokespersons for the needs and the expectations that a community has of the school.

Another aspect is that the teacher considers that policies constrain their actions and don’t provide liberty to put their practice according their own interests and of the school communities. For the teacher is not only important to find a meaning to his teaching, but to help place students in a context where they can find meaning for their existence, and it has to do with providing spaces that allow

redefine the relationship with knowledge making room to find multiple ways of understand and interpreting.

Include the latest disagreement with the assessment policies, considering them less demanding and be based on the concept of quality statistic, related to coverage and efficiency parameters and not as a capacity to respond to the environmental demands, or academic challenges of the new citizens.

School curriculum guides what to do in the academic field in flexible way to allow its innovation and adaptation to the specific characteristics of the cultural environment where it is applicable. According to the article 78 of the 115 Act of 1994, every educational institution shall maintain curriculum development activities that include research, design and permanent evaluation of curriculum. In general in the year 1998 the National Minister of Education proposed curriculum guidelines of the mandatory areas, which have been fundamental to create key inputs for the curricula and the definition of that teaching strategies each educational centre adopts. Proposal of guidelines was enriched with the participation of teachers of various regions and academics, as well as consultation with curricula in other countries.

Later in the years 2002-2004 with the help of specialized teachers from different areas, the Ministry of education gives the country a proposal of curriculum standards of mathematics, Spanish, natural sciences, and environmental education areas. The initial proposal is submitted to the study and analysis by the educational community in a period of 12 months to produce official standards. With the standards seeks to give greater concreteness to the guidelines issued previously, equip school institutions with a common information to formulate their curricula, respecting their autonomy and respond to fundamental problems of education in Latin America to the goals to improve the quality of education as a standard in education specifies the minimum that the student should know and be able to do for the exercise of citizenship, the work and personal fulfilment information. "The standard is a goal and a measure;" is a description of what the student should be achieved in a particular area, grade or level; "expresses what to do and as well to be done".

The initiatives in curriculum in Colombia, in recent years have dedicated great efforts to the creation of a national system of evaluation (Chapter 3 general education Act). The system aims at first, design and apply criteria and procedures for assessing the quality of teaching and secondly, assessing the professional performance of teachers and senior teachers, the achievements of the students, the effectiveness of teaching methods, texts and materials used, administrative and physical organization of the educational institutions and efficiency of service delivery. This part is regulated by Decree 1860 of 1994, then repealed by Decree 230 of 2002 and later repealed by 1290 of 2009.

"In the Article 102 on textbooks and educational materials, the general law of education of 1995 is expressed that the National Government, earmarked annually for texts and materials or educational equipment for use by students in institutions educational status or hired by it, an amount not less than the resulting amount obtained by multiplying the equivalent to a monthly minimum wage by the total number of formal educators. These resources will be managed by the Fund of social investment, FIS system of co-financing with the territorial entities in whose charge is the provision of educational public service, in accordance with the regulation issued by the national Government to the effect. Textbooks, who purchase, must be defined in accordance with the institutional educational project and will be part of the library of the establishment concerned".

For this purpose different strategies have been established as the creation of institutional *Bibliobancos*, available for teachers and students. The choice of texts is done based on some general criteria paths by Ministry of education committees and local Secretaries of education, agreements who in turn exhibit catalogues of bibliography for managers and/or professors.

Over the past five years, it was unusual in some cities, the realization of the "pedagogical showcases" events which representatives of the institutions should go to select the bibliographical material. Sometimes the choice is distributed in texts Guide, “not textbooks” reference text books as thematic, specialized and biographical dictionaries; geographical or human atlas literature (literary works of any

kind), news (all areas of knowledge that contribute to the development of the institutional educational project materials) and other various media such as CDs, DVDs and videos.

School text has undergone transformations looking for strengthening it and adapts it to those proposed teaching based on quality standards and competencies to be developed up to eleven students from kindergarten. Eventually, optional are made studies (Colombia learn) opinion among teachers to know what your preferences to choose texts are school guides, for their classes. Also, academics propos studies criteria studies discipline and training for the selection of texts. (Standard technical Colombian NTC 4724.) (MEN)

2. Relationship between research and practice / teacher training

Vocational teacher training processes of teachers has changed in recent years due to reforms that modify times and organization of programs at the Licenciatura curriculum and administrative organization and academic organization associated with the processes of accreditation, both the accreditation of quality and records of programs. The term teacher training includes both initial training and training in service (this last also call development, permanent or continuous training). 8

Fundamentally the initial training of teachers in Colombia is led by three types of institutions: one the Superiors normal, two the faculties of education from public or private universities and three National Pedagogical University is a university institution dedicated exclusively to teacher training.

Higher normal schools are teachers for pre-school and basic primary education-educational institutions. The role of higher territorial entities normal schools is important and enjoys wide recognition from other establishments taking them as a reference point and model its processes, not only for the training of teachers but also as an educational institution in itself. Some decrees have demanded its restructuring, the normal schools were reformed and became them normal superiors, who must establish an agreement with a Faculty of education, articulating the training system so that there is continuity, coherence and support between the different cycles. These schools training covers part of designated as education media vocational training and extends one or two years.

The faculties of education are required a reassessment to the integral formation of the educator, strengthening educational and pedagogical research and the formation of academic communities in this field. This has led to modify some academic processes in Licenciatura, specialization and master's programmes for teachers. Processes impacted **UPN** in their quest of improving training processes and achieve quality accreditation for most of them. The majority of Licenciatura have duration between four and five years, while specializations lasts one year and the master's two years.

There are currently two teaching effective statutes, 2277 Decree 1979 **and** 2002 Decree 1278, which define in each case the type of linkage, permanence conditions and requirements for admission for teachers mainly dedicated to the official service.

The second Statute defines the possibility of Licenciados courses professional income resulting discomfort in the teachers and greater fluctuation on the floor, because in the last year has increased the percentage of teachers who renounced the appointment in different State institutions.

Similarly in the two statutes differ ascent processes and promotion towards better conditions for teachers (associated with wage recognition), for this reason have lost importance specialization programs while the master titles represent an opportunity for promotion within the structure for teachers belonging to the two types of statute.

However, in the context of low economic, moral and professional incentive has teaching, the access to higher levels of knowledge and skill results in a springboard towards better work alternatives. The difficulty to attract the best candidates for teaching and for retaining qualified staff determines a high rotation and restarts a continuum of teacher training programmes.

Law 60 of 1993 in his 3rd article defines that territorial entities shall co-finance educational projects and promote, evaluate and facilitate training and updating of teachers. Complements this capacity of decision of the local communities in the school autonomy to define their institutional educational project, according to "the situations and needs of learners, local community, region and country" (Law 115 of 1994, articles 73 and 77). Law 115, in its 4th article, establishes that the State must attend

permanently qualification and training of educators, educational promotion, resources, and educational methods and innovation and educational research, among other factors favoring the quality and the improvement of education.

Of the processes of training also importance great teacher PFPD constituting a good option for improving wage conditions of teachers and professional qualification permanent training programmes. These programs are developed by universities and other non-formal institutions.

Despite Government efforts for the co-financing of teacher training, budget destinations have been scarce and most of the responsibility has fallen in personal teachers who want access to training opportunities.

The policy to the teachers serves as a strategy to adapt to the demands of a globalized world. In this case both politics and science take an interest in the narratives of progress; education seeks social life skills, habits and behaviours generated from the exercise of rights and democracy. The policy provides a frame of reference, norms and values according to which education should be done. The speech at its base determines the meanings assigned to education, subject to the challenges imposed by the society from the industrial to the globalized.

The second theme that guides the analysis of the study at a large-scale is the reference that guides teaching practices, understood as the interplay of epistemological assumptions, educational, and social leanings are the basis of what the teacher says it does when surveyed. Aspects like the importance that the teacher gives to the composition and membership of academic communities are highlighted, and like the privilege it gives to certain sources of knowledge, the interest to qualify their practices, particularly science education, links with other school actors and strategies and the models or approaches that guide its teaching.

It is important to see how teachers rescue the experimental nature of science education at school, even though they do not have the same implications. For some, it has to do with the pursuit of a method called the "scientific method" that involves close monitoring of how to proceed in a laboratory experiment or situation, that interest seems to be inherited from epistemological trends addressed by studying internal organization of science, methods, ethos, and dynamic languages. However, the practices of education have been biased towards the objectivity of science and theory testing. For other teachers, the methodology is related to the learning of scientific skills I in solving problems in this perspective the important thing is to check the truth, but the development of certain forms of thought that allow students to explain situations, which reveals slightly approaches to developmental psychology of thought.

It can also reveal methodological positions related to competence development, where knowing to think, knowing to do, and knowing to know are dyads that should guide the intentions, skills and understanding of student learning. Speech is related to the competency assessment, which starts tied to language skills and then permeates the different areas of knowledge. The idea of competition is that a competent student is equipped with cognitive and procedural tools to act in context and to advance processes that allow the interpretation, argument and propose, either in a test or in matters of daily living. Coupled with the skills, place the developments of language, either their own science or general knowledge, reading comprehension, technological thinking or values education stands today as a task that includes all academic disciplines. In many institutions there is a requirement to master the development of cognitive skills, procedural and attitudinal area plans.

Many teachers highlighted the interest in the relation between theory and practice, but from different positions. Sometimes as a mere demonstration of a concept in a class, sometimes as the possibility of extending the point of view of a subject with theory and critical understanding of reality, others such as the acquisition of cognitive and practical tools for developing a comprehensive and effective action in a world that has been technified and / or modified by man's social action today.

As for the **motivational** aspects the three regions highlighted the importance that the concerns of children, the wonder, wanting to know everything, initiative and the ability to project the interests of students, as prerequisites for an enjoyable and dynamic class that has activities that encourage

children and teachers together. Sometimes the motivation is related to the dynamics of the class at the confluence of creativity of the teacher, the recreational use of different strategies, the promotion of good human relations, among other things that move the heart of teaching in content and place it in the construction of environments for learning and school capacity to provide the child elements of socialization.

As one element of motivation, the content of the class is taken into account. This is understood as the ability to embroider situations or problems that are related to students' life. For example, the relationship with the natural, personal and social environment is enhanced. This situation reveals a tendency towards addressing contextual issues

Regarding cognition, all regions agreed in linking the child's mental processes with the ability of an individual to stand comprehensively in a particular environment, ie that certain developments in science allow people to act with greater skill in the world, sometimes emphasizes the importance of scientific rationality in the formation of students and others simply recognizes a contribution of science to provide students with elements to function in life. But know the main concepts, hypotheses and scientific theories and be able to apply them, can give rise to numerous debates. What are the main concepts? What does it mean to know? What it means to be able to apply? "School curricula should focus on opportunities for students or what matters to the scientific community? Should we focus on a series of special knowledge or on a more accurate global set to reside in the universe?

There are few teachers who explicitly express a relationship with thought processes that have been treated extensively by teaching approaches in research, significant knowledge or teaching for understanding, that they receive wide promotion in the 90's and in the year 2000 in Colombia. Although the term "knowledge building" is common, what is expressed does not make explicit what that building consists of. A term that enriches it is rarely found. By contrast, cognition is understood generally as logic or thought processes.

There are very few teachers that involve structural elements of cognition into their speech, like: time, space, the change to which science would play an important role to enable students to make sense of their immediate environment.

Regarding the ***relationship with the context***. The three regions call for the transformation of reality, the world. They highlight the role that schools have in the enrichment of everyday life and where the language of science gives students new ways of interpreting, and also establishing a close relationship between man and nature, in which the understanding of personal balance allows the understanding of the balance of the other beings of nature also highlight the goodness of the application of technology in solving environmental problems. The context here is located in what is natural and in the impact of human action and the possibilities to correct or lessen this impact.

Some teachers blend the relationship between science education and context with elements of ethical, political or ideological frames that place the transformation with social and philosophical referents. The theoretical assumptions of these kinds of teachers place it in the interdisciplinary frame and even more in the cultural.

Overall, the actions of the schools are routed towards the solution of the social group problems. The relationship is almost always established from the inside out , based on what schools can do is rarely seen in another sense, unless the context is a source of situations that stimulate new situations to address

The problems with context highlighted as urgent and immediate have to do with an understanding of the problem as "something that harms or hurts" and that the school can provide for their solution. When the problem is a situation that provides students with elements to explore or to raise questions or to encourage explanation it is because a cognitive character is assigned to it.

As an important goal for science education, teachers select "Teaching science to develop critical thinking. For this, they propose two groups as follows:

In the first case, the teacher reiterated the reasons for the selection, the belief that **critical thinking allows to live in society**. Here, again you can see how the social concerns are highlighted, having to do

with understanding a society in its conditions, history, organization and the role of the reflective individual on welfare. In some the psychosocial relationship between the people and society centred in the awareness of a relationship is though to herself, to a collective consciousness that is known and as such transcends and creates new realities and worlds. Also loom sociological references related to democratic principles, who has worked lately, such as coexistence, peace, diversity, and others that guide the exercise of citizenship, in search of rights.

The second case indicates that **Critical thinking is important to understand the environment and solve problems**. This may relate to epistemological references that understand the critical and the critical ability to question knowledge, to challenge the conditions that determine a situation, to risk arguments and solutions. Being critical is knowing how to think and learn to propose, namely to question the previous experiences and sciences that offers various strategies to transform and shape thought of the world. The security of scientific rationality underscore once again, with its certainties, demonstrations, methods and scope. But, being critical, is also for a few teachers limited relationships between the sciences and social, human, economic and ethical context is to give a character to your productions, is to lift its limits of utility for progress and human welfare. It shows the environmental issues of concern to both men in these decades.

Within the epistemological components of critical thinking, the relation with the applicability of the findings of science, or with the usefulness of his techniques is highlighted, a pragmatic knowledge of science is assigned, in some cases technological nuances as a literate person will have learned that technology is as a way of proceeding, rather than a tool used. In other cases the nuances promote an ethic of the individual who knows it takes a framework framing behaviour, health-care and ways to decide which address specific issues related to substance abuse, spending money, work or other circumstances.

On the other hand works like those that have been done by the IREC group may account for the processes of training science teachers in Colombia and the possible epistemological positions taken on them in such a way as to conclude that in Colombia, in the initial training programs of teachers, there is a predominance of oral transmission and rote learning of curriculum content which probably causes the same results in primary and secondary (middle school) education, the same group says that this has led teachers of science in the country most probably to have been formed with little criticism from the texts used in their formation, transmitting positivist views of science and misconceptions contained therein. Also ensure that the current science education and in their socialization the specialized journals do not play a central role in concluding that science education is a "science product," "technique." There for, now we can conclude that more than a policy which is denoting the above statements is a particular view of science and its teaching that have in general the programs in teacher education.

How do teachers perceive the relationship with education policies?

Regarding knowledge that teachers have on the **policies and guidelines** affecting education and the positive or negative aspects about their effects. The screening criteria have to do with the policy coverage: international, national and local level with teacher training and curriculum organization on projects. The references that are the basis of the terms of the teachers have to do with his political education, with emphasis on curriculum, assessment and the pedagogical approach that animates it. Few links are established with international trends in politics, barely with the standards, TICs, bilingual Bogotá and international tests, international relations are achieved. The policy in this case serves as a strategy to adapt to the demands of a globalized world. In this case both politics and science take an interest in the narratives of progress; education seeks social life skills, habits and behaviours generated from the exercise of rights and democracy. The policy provides a frame of reference, norms and values according to which education should be done. The speech at its base determines the meanings assigned to education, subject to the challenges imposed by the society from the industrial to the globalized.

In assessing the implementation of policy, we reiterate the importance of the link between science education and society. But tending to social issues, for example, science does not question at any cost the assessment as factor of social change, not questioned by the economic decisions arising from their research projects or political interests that guide teams work. So much criticism is unable to carry out educational proposals aimed at giving students the necessary knowledge. It persists in the priority task of training students so that they can speak well of this world; Which in previous decades was considered the exclusive task of the scientists. Today it is a prerequisite of democratic societies in which citizens express issues that affect them. Individual citizens make political choices, are in favour of proposals that have scientific and technological base (health, environment, improvement of agriculture)

Teachers establish a relationship between implementation of school policies and the emergence of research initiatives, associated with specific programs, this is how its read:

Linked to national politics. The teachers of the three regions agree in stating programs like Project WAVES, TICs, PRAES and recognizes that they generate research and innovation practices in schools. Also, an international influence or look is sensed in these programs which are implemented at national level in particular as it relates to international policies related to assessment of learning.

Questions have been generated, not to the content of policies or standards of competence, but to the mechanisms for promotion and evaluation of learning that account for the effectiveness of the policy. However the relationship between research and practice is clear, as these policies involve a change in the purposes, in the content or in the procedures of teaching, but do not change the teaching practices of teachers who do not get linked to research processes.

Related to teacher training. These enhance learning; they get liked with the University, with postgraduate training, but declare inconformity by low contextualization, limited guidance, lack of continuity and resources.

It is assumed that all programs of permanent teacher training are related to the policy from which they are directed. The relationship between educational policies - training programs - teaching practices is clearly perceived. This relationship left some questions regarding the ways in which models are posed obey to the models of training, its instrumental, not intended to generate comprehension, reflection or transformation in the teacher, but only for him to operate. The support for teachers that continue their education and those who encourage research has been connected with the encouragement of industrial awards and salary incentives for teachers.

One of the major mistakes that is expressed is the inclusion of unlicensed professionals to teaching scenarios because they believe it does not contribute to children's education and research in school.

They promote academic communities and school communities. All national and regional initiatives regarding the organization of networks, forums and research groups are considered successful. However the inconformity with the large gap between policy guidelines and educational context appears once more. They continue to reiterate the gap between public policies applied regionally or locally, and the classroom contexts.

They reveal a more direct link between research and teaching practices because they required teachers to engage in dynamic research, for which the socialization process, the creation of working groups, events that are organized, are all strategies of validation and confrontation of knowledge or findings that emerge from the systematized practices of teachers.

Linked to the development of transversal projects. The creation of study groups and the development of projects that involve the school at a transversal level have been encouraged. The support of a number of technological tools has been sponsored.

The initiatives reflect a concern for the contexts of each region: the problem of the social dynamics relevant to a determined city, for the conservation of natural environment with transversal projects. Some of these initiatives in the regions incorporate the ethnic education projects as alternatives of transversality.

There is a strong correlation between the programs that articulate teachers and research initiatives that existed previously. The teachers have participated in research processes linked to the degree or work practices that require innovation within teacher education programs currently who are currently in practice

From the Ministry of Education and from the Regional Education Departments there have been continuing education courses and counselling to transversal projects that have been promoted for teachers to identify as opportunities for delivering a research activity from their science teaching practice. Among the most frequently mentioned are the projects WAVES, COLCIENCIAS projects, the inclusion of TICs, and guide to PRAES.

In the area of the institution teachers also recognize research initiatives that focus on the acknowledgment of the school's own needs and the closer contexts. As well as in some cases it manifests the importance of them to create teams of teachers, in most cases interdisciplinary teams.

Additionally, processes that the school developed with other governmental institutions have been mentioned, which provide advice to institutions on specific issues and contexts.

In the comments against these initiatives and participation in research processes in school teachers manifest a great attitude and a willingness to participate in them, but in the cases that difficulties are stated to the lack of contextualization with the knowledge is brought up and also with the institutional processes and la local needs. In the same manner, the difficulty that the schools organization presents in taking the time to plan such activities.

Participation in the research process produces personal and professional satisfaction. Teachers consider that their participation in these processes has required deeper disciplinary and pedagogical aspects that has contributed to the institution and from which they have received personal and professional satisfaction. **The participation in the research processes has generated an impact on students**. It becomes relevant for the students learning processes, thought processes in the generation of attitudes, learning concepts, among others.

The reflection of the goals that are imposed on the teaching of science, related to the integral development of students, is put forward. This is intersected with science, student and a school glance that teachers report, which is consistent in their concerns by training in skills, critical thinking, scientific competence or attitudes toward caring for the environment.

Participation in the research processes generates changes in the school context. You can generate work processes with the school community that can modify their conditions of a healthy environment, of caring for the natural contexts, of conflict resolution in the community, and of the conditions for production.

The participation in research processes are projected to the community. Actions are generated which not only change knowledge, attitudes, behaviours of students in the school but also in their context and then radiate these actions to their closer communities

The participation in the research processes requires the construction of academic communities. It is recognized that research is an activity that requires socialization processes and exchange with colleagues to make social knowledge learnable. Hence, this is one of the elements that is recognized as relevant and significant. Being able to present what is done in the institution and share the successes and difficulties with others, as well as to know what is done elsewhere. They are Included in the forms of socialization both verbally and written.

The investigation becomes a source of personal, professional and social satisfaction, because it allows the teacher to develop its initiatives in the classroom looking for better training for their students.

Recognition of the activity that the teacher develops every day, in a systematic manner is made, with the intention of improving the learning processes of students and gaining their own personal and professional satisfaction. In this we consider a series of obstacles which have already been mentioned in detail but which nevertheless hinders investigation in schools, but rather what is done is demanding better conditions. Teachers have been involved throughout all the culture of research which is

inherent to the teaching profession. From there a different school organization is considered necessary, one that allows teachers to organize work teams, extending the time commitment of teachers to from research and thereby achieving the same resources.

There are a large groups of teachers that have special focus on local policies and in the guidelines of transversal school projects (environment, sexuality, cohabitation, Law 115) for considering them successful. They are based on the importance of change and institutional renewal in the furthering of new school organizations and guidance on the structure of the curriculum, providing the possibility for realizing the interests of the teacher, by encouraging the leadership and membership of a collective project. It is noteworthy that social and political weight is given to the participation in projects, the teacher is assumed to be and active and a creator of alternatives for the school. However there is no uniform way to participate and to position itself as a subject who chooses and decides on its circumstances.

3. Interaction among teachers

The Networks are created as a space that fosters the development of teachers, so much that the reflexive actions influence the teacher as it generates the possibility of looking at himself and it also touches the collective action as it allows for comparison with others, confront it and situated in a particular space.

The teacher is recognized in the idea of participation, training in the best cases, understood as actor and author of his own educational processes, epistemological, ethical, aesthetic, political and other aspects that constitute the entire subject. Acquisition of transforming elements of the action in the classroom, in terms of motivation, the gathering of new methodological tools, the multiplication of perspective and ownership of project collective is also highlighted.

In the opinion study the networking as an alternative to the academic organizations of teachers; however their recognition is low, despite the insistence of advocacy and universities in their formation, despite having deployment in the City of Bogotá, for over ten years in the formation of a large Network of Science Teachers. “Trends and research organization have changed so rapidly in recent years.

The teachers have participated in research processes linked to the degree or work practices that require innovation within teacher education programs currently who are currently in practice. In the area of the institution teachers recognize research initiatives that focus on the acknowledgment of the school's own needs and the closer contexts. In some cases it manifests the importance of create teams of teachers, in most cases interdisciplinary teams.

It is noteworthy that social and political weight is given to the participation in projects, the teacher is assumed to be and active and a creator of alternatives for the school. However there is no uniform way to participate and to position itself as a subject who chooses and decides on its circumstances.

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Some teachers assumed that they have a difference of opinion with the bulk of the teaching community. It expresses the fragility of the community of science teachers that although we have tried to promote from development and construction of spaces for debate still deserves to be strengthened further as a strategy for circulation knowledge and qualifying teaching practices.

In the opinion study the teacher is given a leadership position in relation to the practices of the institution that is in correspondence with the perception of the impact of the criterion of colleagues in his own practice, it also shows that the leadership of science teachers in educational institutions, situation that is corroborated empirically.

4. School administration/Lack of resources

In the last decade, the education policies in relation to teachings of science and the policy of science and technology have not shown major differences in what you want from the international benchmarks "Millennium Goals ", and hosting almost verbatim on behalf of the national documents, COMPES, National Policy on Science and Technology, National Planning and District Development and Education. Be warned, that if, in general statements of policy are presumed to comply fully with policies of neoliberal trend enunciated by the government of President Gaviria and his education plan for Peace and in the annual report 1999 - 2000 states five policies in his speech as: The social mobilization for education, equity (education by results and expanding the access and permanence in the occasional system based on improving the efficiency of the system) , decentralize the school making an autonomous organization with the capacity to make decisions regarding its resources, efficiency based on reassignment of the number of students for teacher, reassignment of positions, funding by results in coverage, quality and achievement articulating with equality and ultimately improve the requirements of quality education by the community, information on student achievement, the transformation of teaching methodologies and the use of books as learning tools.

These policies have propitiated an increase in coverage that affects the ratio of number of students by teachers, who met at the national level as a rationalization of the Faculty and which led to the establishment as a parameter of teachers by the 3.16 course. Likewise the number of students at the national level ranged from 28 to 35. This number varies depending on the area; in rural areas the number of students per course is low and in urban areas is close to forty students on average.

Internet connectivity has improved in most institutions in the country. A program of the Ministry of national education called *Computers to Educate*, which has been strengthened through *Colombia Learn* portal has played an important role in this process. These programs have had a greater impact on rural and remote from the capital territories.

However, in the opinion study the teachers assign a high influence on their practice to what students learn, to the disciplinary handling of the issue and to the courses of update. In the second level we find the tests that evaluate learning the interacting with colleagues and socio-cultural level of students; finally teachers attribute a low influence to the interaction with the rector, the coordinators and the text books. The teachers privilege the relationships with their colleagues about the relationships with the directive personnel.

5. Socio-cultural issues

In the opinion study the teachers opted for an answer denying that the gender gap is a problem in the classroom. In our country children of both genders are admitted in the same classroom, except in some private institutions run by clergy. State schools are mixed, those seeking access to them can easily get in. Currently students are registered with the local coordinators who then assign the institution for each child. In the respective institutions courses are organized according to criteria such as age. Sometimes it is felt that the schools organization by gender does in fact affect the students coexistence, but not its academic performance.

So, the question is when and how a situation has acquired the characteristics of a problem? How does the collective consciousness operate so that at certain times or places new problems are adopted to be addressed by education? In terms of civil rights, gender is a source of proposals and regulations. Why if in the context of national laws, they speak in terms of gender issues they don’t these translate these themes for the curriculum? Moreover, should this be included as a subject?

The teachers' responses do not pose gender differences as a problem, just as bias in personality, taste or behavior. And if they do take into account differences they would do it in respect to the opinion about a certain topic or activity that was introduced. They advocate towards equality in terms of learning capabilities and equal opportunities for participation.

For teachers there is no report of major influence of cultural or gender differences because it is believed that children have the same potential to learn science, that is, they see no difference in opportunities to learn, but they do see that learning must be given according to their needs and obviously plays an important role here their own contexts.

For teachers of our country is does not establish a distinction in the way to organize and develop our practice. Although sexism is present in our everyday and in our workplace, the teacher does not recognize gender as relevant to establish differences in the development of academic school activities.

6. Best practice

Being able to articulate assumptions about the meaning set forth on policy by teachers overflows this analysis, some projections can be made in the continuation of this research however they are not even visible in the analysis of the opinion polls, the "alleged breach" between theory and practice if policies are impacting the school, if the impact is severe or if it generates counter proposals in school players, if the management or development of the policy is done in a passive or active way, obedient or dissenting; for the moment we could think that the teacher re-contextualized the senses of the policy and put them into practice in their own ways. Politics is not the only one who directs the activities of the school, school and the actors of the educational system. In particular teachers make the school an ideal stage with other ideological meanings. The school thus becomes a land of culture resistance, of counterculture, where the natural tensions between hegemonic speeches and reflections on teacher's own actions coexist, it is clear that the teacher the initiatives gestated from, in and for the school, with their active and reflective participation, while the national policy on science and technology, national education policy and district policy seeking to meet international and particular political interests from outside, peripheral to the real problem without further reflection on the school context, their needs, their expectations.

However is not perceived as important to reflect on the influence and intervention of outsiders to school but if it gives priority to the possibility of linking the results of research on educational practice and difficulties that arise in this area.

Regarding the difficulties we mention:

Institutional conditions such as lack of support in relation to time, resources and the recognition of research that teachers do within the institution.

External conditions of the institution such as the lack of recognition, incentives and means of dissemination of what is being done from the school in terms of research initiatives. The small articulation between research - education policy is also mentioned.

External conditions related to infrastructure such as economic resources, physical space, support in managing school activities, procurement of educational materials, these elements are repetitive in the expressions of teachers.

It stands as a critique of the disjunction between the policies that they propose and contexts. Nonconformity is common, of knowing-us subjects consumers of politics and decisions that others make. At the base of this critique is the inability to decide as a society, to determine domestic destinations and recurrence of opinion on the economic dependence of our country. Not to lose sight than in previous decades the union of teachers, enjoyed great development association that allowed certain critical positions. On the other hand, include the latest disagreement with the assessment policies, considering them less demanding and be based on the concept of quality statistic, related to coverage and efficiency parameters and not as a capacity to respond to the environmental demands, or academic challenges of the new citizens.

The teacher is continue to be measure as process-product, from the outside to the class action, it is assume as a researcher to equate him as a production models of knowledge supported by society and motivate them to compete with other professionals in a society that values the utility and productivity within the models of efficiency and effectiveness proper of the economic contexts of the world, it hardly challenges the true condition of the teacher, not knowing if the same interests trying to determine economic and social development of the nation for the increasing number of researchers or number of publications, research groups or professional on post graduate training, are the interests of the classroom, the teacher and students, without really evaluating whether the school would have to take rational and technical processes undertaken for the production of historical knowledge and well validated as a source and generator of development along with their teacher researchers. It is possible

that the school and its players need a new and distinct recognition that shifts policy around this issue and let the teachers that know the political savvy but not necessarily be a uncritical performers of them, the educators interviewed generally claim less fragmentation in politics, but more management and monitoring of the same, which somehow implies that the classroom is a territory of explicit and implicit political debate.

In the opinion study finds that teachers give high importance in their practice to exchange ideas with other colleagues about successful or unwise actions in class, develop new teaching materials, increase material and financial resources schools. In the second level are: changing the way teachers are updated or training, building specialized laboratories, ensuring Internet connectivity, linking the practice with the results of educational research, reorganizing the work of teachers and finally teachers attributed low involve to external actors that influence teaching practice and change official requirements. The following table shows the summary of these trends.

1=Unnecessary; 2=A Little important; 3=Important; 4= Very Important; 5=Necessary

Actions	1 2	3	4 5
Change official requirements	21,15%	30,13%	48,72%
Increase financial and material resources for schools	2,56%	15,38%	82,05%
Change the way teachers are updating or training	5,77%	14,74%	79,49%
Rearrange the teaching work	7,69%	21,79%	70,51%
Involve external actors to teaching practice	15,38%	28,85%	55,77%
Exchange ideas with other colleagues about successful or unwise actions in class	2,56%	14,74%	82,69%
Build specialized laboratories	3,85%	17,95%	78,21%
Secure Internet connection	2,56%	19,87%	77,56%
Develop new teaching materials	2,56%	14,74%	82,69%
Linking practice with the results of educational research	0.98%	8.33%	72.06%

These actions can be linked together to generate clusters as follows.

GROUPS	LINKED WITH…	PERCENTAGE
Administrative policies and infrastructure	Increasing material and financial resources	82,05%
	Secure Internet connection	77,56%
	Build specialized laboratorios	78,21%
	Change official requirements	48,72%
Teacher training and qualifications	Exchange ideas with other colleagues about successful or unwise actions in class	82,69%
	Change the way teachers are updated or training	79,49%
	Rearrange the teaching work	70,51%
	Develop new teaching materials	82,69%
School's relationship with the outside	Linking practice with the results of educational research	72.06%
	Involve external actors to teaching practice	55,77%

In relation to those actions that are related to administrative policies and infrastructure, teachers favor increasing material and financial resources, this action as a condition for improving teaching and learning of science is increasingly felt by teachers and which does not correspond with increases in coverage or quality requirements of learning. In connection with the processes of teacher training and qualification, relationships with colleagues related to the action to improve teaching practices are still standing out, this choice would make it foreseeable that it would have more efficiency in the qualification of teaching practice, develop training strategies from the achievements of proposals developed by other teachers, facilitating knowledge exchange and the spread of results.

Finally, in terms of the relationship with the outside school intervention by external actors, it is not seen as important, on the contrary, to relate the research to educational practice is seen as important, what shows that teachers also identify or are aware of the gap between teaching practices and developments in educational research.

General issues for cross-comparison - Israel

1. Relationship between official guidelines and requests and science education practice

The ministry of education is responsible for the development and application of a national curriculum in science for all schools, excluding the ultraorthodox sector that do not learn science (19.7% of the population of students in Israel in 2007).

The department for curriculum development at the ministry of education is responsible for curriculum design. There are subject-matter committees for each discipline, responsible to direct the educational system's policy of teaching this discipline. The members of these committees include researchers, teachers and supervisors.

According to documents published at the departments' website, educational principles underlying the curriculum include social, cultural and economical considerations as well as epistemological considerations, the relevance of a specific discipline to other disciplines and possibilities of integration between them. The goals directing the curriculum development include mainly knowledge of content and knowledge of skills and competences.

Recently, the department for curriculum development designed a new middle school curriculum in science, which they published online and asked for comments from researchers, curriculum developers and teachers.

There are rules for performing research in schools. Any educational research in the system of education requires the approval of the chief scientist at the ministry of education, who is responsible for allowing research activity at schools that will not have any negative influence on students. This may be relevant when the relationships between researchers and teachers involves also students.

Otherwise, there are no specific rules regarding participation of teachers in research. Of course they need to get approval from the principal and sometimes the district supervisor too.

Usually participation of teachers in research is based on personal opportunities and personal connections between researchers and schools, national centers for science teachers or supervisors.

When the ministry of education decides to lead a reform or a large scale program, they use the national disciplinary teacher centers to develop and implement teacher training in cooperation with district inspectors. Teaching materials and other resources may be developed at the national centers, in cooperation with science teaching departments or by other qualified people hired by the ministry of education.

For example, current efforts (in the last two years) in middle school science include preparation of teaching and learning materials in agreement with the new curriculum, followed by professional development for science teachers and a special training for leading teachers (about 300 people), who are responsible to work in schools all over the country with science teachers. The ministry of education funds the development of materials, professional development, teaching hours for the leading teachers etc.

All textbooks must have the ministry of education's approval.

There is a rule that schools must continue to use the same textbook for 5 years before changing it.

When new textbooks are developed, the publishers send advertisements to schools and teachers on their mailing list, and sometimes even give free examples. The science team in a school can decide if they want the book (which was already approved by the ministry of education).

The authorization for testing and assessment, which is a separate body not dependent on the ministry of education, is responsible for development and assessment of national standardized tests at 5th grade and 8th grade. There is another national test at 7th grade, which is developed at the ministry of education.

Teachers perceive these tests as a necessity and often direct their teaching toward preparing for the tests.

2. Relationship between research and practice / teacher training

In-service professional development is offered by local and national teacher centers in the summer and along the school year. Often the professional development is associated with some salary increase

(external motivation) for teachers who complete it, but there is a limit to this increase. Therefore some teachers who reached this limit cannot get any compensation for the time and effort they invest in training. As a result, they have no motivation to participate in PD.

In some cases the district supervisor can force all the science teachers in the district to participate in specific PD. In other cases the teachers can choose their training course out of a list decided by the principal and supervisor.

The new reform called "new horizon" defines some frames for teacher training – about 30 hours a year of PD, some focused on content and some on other educational issues, like pedagogy, management, affective, social and environmental etc.

Of course, there are some teachers who are internally motivated to improve their teaching and continue to participate in PD regularly.

For schools who participate in "new horizon" reform some of the workshops happen during working hours in school and some happen after it.

For schools who do not participate in the reform everything is after school or during teachers' free day (teachers can choose one free day, since the school works 6 days a week and teachers work 5 days).

There are mixed perceptions. Some teachers appreciate research, and some teachers are not aware to research. See our interview analysis.

3. Interaction among teachers

In MS there is 1-2 hours of team-meetings every week as part of the schedule. One of the teachers is a science coordinator who manages the discussion.

Since last year (part of the new program), Once in 3 weeks there is a science-district teacher-guide who joins the team-meeting and discusses new subjects raised at the ministry of education.

In these meetings teachers usually talk about the curriculum, pedagogical problems, how to proceed, how to interest students. Sometimes there is not enough time.

In many schools the science coordinator can follow the teachers through a computerized system- can see the topics learned, homework, students' grades, and can transfer learning materials and messages to teachers and students.

Some teachers work regularly with email, helping each other by asking questions, commenting on lesson plans etc.

Some teachers lack the equipment at home or at school, or have concerns about using technology.

4. School administration/Lack of resources

The number of pupils per class used to be 41 and was recently reduced to 35.

Some schools have better facilities. Usually there are problems like many classes using the same labs. Sometimes lack of equipment, procedure for getting approval, money,

In some schools there are no computer labs at all. In other schools there are 1-2 computer labs for the whole school. In some cases a science community center provides labs and equipment for several schools in the same area (only MS).

Internet access – usually if there is a computer lab there is also internet. Sometimes there is internet not in school, but in the community center.

Some classes participate in projects providing laptops to students and/or teachers.

The principal of primary schools can recruit/hire teachers but not fire them, which is the responsibility of the district inspector. In MS and HS the principal of the school can fire teachers until they start their third year of work at school. In High School the principal manages the budget, but in MS sometimes there is a higher principal who approves everything. There is some autonomy to principals.

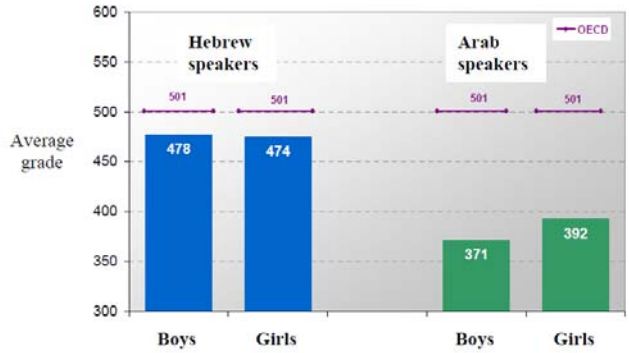
The principal is given a number of hours that he has some freedom how to give to teachers. In science recently there is no freedom- the ministry of education publishes directions about the number of hours that should be dedicated to each topic.

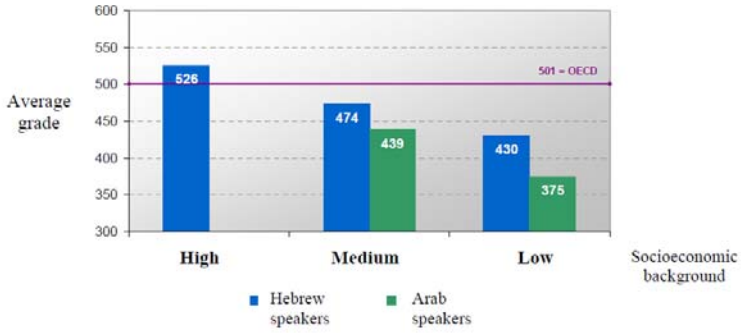
The principal chooses his team of teachers and coordinators.

Regarding practice usually the coordinator (pedagogical or other) is responsible for teaching practice.

5. Socio-cultural issues

Here are some results of PISA 2009 test that were published this month:





6. Best practice

We have answered this question in detail in our report.

General issues for cross-comparison - Spain

1. Relationship between official guidelines and requests and science education practice

According to last education act (LOE, 2006) Catalan education has shift its curriculum to a competence-based framework in primary and secondary levels. This curriculum is focused on the mobilization an use of these competencies contents.

Actually, both teachers and researches had manifested their claim in the interviews regarding the lack of involvement.

This information is not included in our report because it is not applicable (these rules do not exist)

It depends on the reform. In the report we mention different kind of reforms or initiatives. For material resources increase (such as digital laboratories) the main support has consisted on specific training mainly focused on technical issues. For the rest of reforms (such as the curricula reform mentioned above) the main support is based in conferences or professional advising (less common)

Teachers themselves choose the book that their want among all the published books. It has to be noted that in Spain there is no an initiative as the one existing in Brazil: there is no a systematic review of the books by research communities.

There are no standardized methods for evaluation. The only general assessments existing are at the end of primary school, only to have an assessment of the primary education, and at the end of the non compulsory secondary education, to get access to the university.

2. Relationship between research and practice / teacher training

The initial training has change last 2 years within the framework of the EEES and Bologna (see section 2.2 in our report). For the continuous training it is not mandatory, but it is necessary to promote and to get incentives.

See section 5.6.1.3, section 6 and summary of results (section 7)

3. Interaction among teachers

See section 5.4 and section 7

4. School administration/Lack of resources

See section 2.2

5. Socio-cultural issues

Spanish educational system is based on a heterogeneous and equitable process (ther is no segregation allowed). No special issues have been highlighted regarding diversity beyond general levels of achievement (no related to gender or ethnicity)

See section 6 and section 7

6. Best practice

For your Country, highlight potentially interesting experiences based on the relationship between research and practice, describing possible structural constraints and barriers that condition their implementation.

b) Summary of the peer reviews on national reports during the Barcelona meeting

Issues interesting for **cross-comparison**	Indicators from the report results to orientate **future field actions**
*Regarding the **relation between research or innovation and practice** in Science Education*	
GROUP 2 (ARGENTINE) Lack of material resources for schools (teachers say). Same in Italy. But what kind of resources? Probably different from country to country. GROUP 3 (ITALY) Research doesn't take teachers' actual practice into account (similar in Spain). GROUP 4 Teachers value networking in all countries. In Colombia networking with other schools is specially referred to. In other countries it's about networking with researchers or with teachers in the same school (applies to next line too). GROUP 5 (SPAIN) Lack of time to work on innovation (probably common to all countries) Lots of teachers involved in research and innovation programmes. But what do they actually mean by "innovation"? In Israel teachers didn't value innovation as much. It might be a very naïve vision of innovation. Our questionnaire doesn't tell us about that. GROUP 6 (ISRAEL) In the description of the national context it seems that researchers are deeply involved in policies. But the conclusions are different. The relation research-practice seems to have to be mediated by authorities. Teacher training emerged as a very central issue	GROUP 1 (BRAZILIAN SURVEY): G1 suggests to involve policy makers and principals in the field actions GROUP 2 The less material resources you have, the more you have to value pupils' knowledge. How can we look at teachers' competences in doing so? Work on exploiting pupils' entry skills. GROUP 3 Teachers to be involved more, but how? Are they really asking to lead the agenda? We have to discuss that with teachers. School is a very self-perpetuating itself. G3 thinks researchers have to have the proposing role. GROUP 5 (SPAIN) Find ways to make research results more accessible for teachers. Involve teachers in research projects more. GROUP 6 Try to foster the teachers -> researchers channel. Work on the naïve idea of science teachers, in order to give them tools to solve their dissatisfaction regarding students learning.

in Israel. The government is funding actions that are (international standardized) assessment related. Researchers instead complain that teachers teach for the tests instead for understanding.	
*Regarding the role and impact of **teachers' collaboration** in science teaching and learning: (teacher community, work with other teachers, …)*	
GROUP 1 G1 asks for more information. How and where does the interaction among teachers take place? Brazil: Teacher associations are not involved in classroom work. Interaction takes place each single school. Difficult to put teachers from different schools together. Both in Italy and in Brazil teachers value collaboration with colleagues GROUP 2 Asymmetry between what teachers think they can contribute to their colleagues' practice and vice versa (can give more than what they get). Similar in Italy. Opposite in Spain. GROUP 3 Is perceived as very important and valued. In Spain and brazil it often happens on the personal level. GROUP 4 (common result) teachers think implementing research in practice is important but at the same time don't value interaction with external actors. Research deals much with gender related issues. Teachers don't. Why is this gap there? Colombia: interaction with colleagues is one of the most important sources of stimuli for the practice. The second one is information sources (media) Digna: teachers are very confident of their competence as a consequence of their high status in the society. They wouldn't think research is significant per se. This seems to be peculiar to Spain. In Italy, e.g., the status of teachers in society is very low and decreasing in time. Colombia: the last legislative measure recognize research activities as an advancement (economical too) criterion for teachers. GROUP 5 (SPAIN) Collaboration with colleagues mostly focuses on behavior/pupil management problems than on pedagogical issues GROUP 6	GROUP1 Important to work on promoting networking and communities of teachers. In Argentine this seems to be very difficult. Not feasible outside the school GROUP 4 (COLOMBIA) Networking seems to be an important theme for the FA as well. GROUP 5 (SPAIN) Take evidence from one class to the other colleagues

Teachers value collaboration but it's difficult to see what kind	
*Regarding the role and impact of **school administration** in science teaching and learning (school principal, head of department, management team orientations…)*	
GROUP1 Teachers mention there is very little time to do innovation GROUP 3 It is hard to understand what the role of teacher is in order to compare it with other countries. GROUP 4 Relationship between economical and educational development is central in Colombian report. But it's hard to find information about the educational system in the report. Some teachers perceive administrators as a barrier to innovation. GROUP 5 (SPAIN) Not enough information about relationships between teachers and principals. In Israel teachers always complain about that. SPAIN: principals complain they have not enough power to do what they mean to GROUP 6 The role of the principal seems to have a central role. Sometimes he's a barrier, sometimes a support. They have the power to stop innovation, but less to foster it	GROUP 1 Organize workshop before the field actions in order to understand how to find more time to work on innovation. Involve the whole school in the FA GROUP 3 What can we really achieve in one year that would be effective? We need to have a strong idea of science education shared at the consortium level. In Israel teachers feel they are not competent enough and want to improve their students' results, which results in lack of societal recognition. Averages in international studies can be very misleading. (maybe we should look at the detail more?) These studies can spread a feeling of inadequateness in the teachers, even if they sometimes diverge largely from the average. GROUP 5 (SPAIN) In order to create communities of practice the principals MUST be involved
*Regarding the role of the **Educational Authorities** in science teaching and learning (policy makers, official requests, ministry,…)*	
GROUP 1 Official recommendations are perceived as very important (different from Italy). Problem of understanding how to assess learning Disciplinary vs. interdisciplinary approach In Argentina there is a problem with biology taking the leading role over others disciplines when one takes a interdisciplinary approach. Physics teacher training programmes disappeared. Same thing happened in Israel as well. Similar problems in Colombia and brazil GROUP 2 Gap between policy makers' and practitioners' interests. Policy makers are more committed to economical problems than cultural. A digital divide exists. The research group chose to	GROUP 1 Work using unifying concepts over the disciplines. But taking logical paths into account. It can be interesting to work on what the lack of resources means in each country.

administer the questionnaires on paper GROUP 3 Indications not important because too many of them. Similar in many countries GROUP 4 Lack of shared learning evaluation criteria. Hard to connect to the rich variety of contexts. Scarce continuity in the policies (probably common to all partner countries). Another common theme: lack of resources. But how does this specialize in the different countries? Are we talking about the same resources? What do teachers think is necessary to teach science and how do they use resources? GROUP 5 (SPAIN) There seems to be more autonomy in Spain than in Israel for the schools. What is the role of (standardized) assessment on each country? In some (Israel) assessment is actually directing learning. In Spain there is only one external assessment at age 18. GROUP 6 As in many other partner countries, too many changes in policies. Teachers complain they are not taken into account in national initiatives.	
*Regarding relation with **Socio-cultural issues** and science teaching and learning: diversity of students, gender, families, …*	
GROUP 1 There is the peculiar issue of indigenous cultures In Argentina teachers say they don't notice gender difference but say they should plan different activities for boys and girls. There are indigenous schools in brazil, completely separated from the others. Many in Salta too. These students have a hard time in going against prescriptions coming from their culture. They have their own authorities, giving educational indications too. GROUP 5 (SPAIN) Programmes to divide pupils according to performance (brazil and Spain). Primary school teachers see cultural diversity in the classroom as positive. Secondary school teachers have a different perspective. Many people separate students according to achievement in secondary school, even if this is not allowed. These teachers think this is the same way to deal with the problem (for example of pupils not speaking the language). This separation	GROUP 1 Work on valuing diversities in culture as related to diversities in learning. What is science in the indigenous culture? What is science in the indigenous schools? How is it taught in the indigenous schools? GROUP 4 Important to work on the differences among urban and rural contexts as emerging from the survey.

happens more in Catalonia than in other Spanish regions. Teachers usually think that, once pupils speak the language, immigration background is not a problem. (no cultural problem) Strangely enough the approach saying that studying maths in English motivates to learn English, but then they separate non-speakers from Spanish pupils during science and maths classes! GROUP 6 Gender is not a big issue. But actually results are more significant than in other partner countries. Cultural difference in the same class also in not emerging as significant.	
Regarding **important ideas of science teaching and learning** (experimental work, contextualization, inquiry,…)	
GROUP 3 Naïve vision of teaching approaches There seems to be no difference between school cycles It seems that teachers feel that a new pedagogy is needed. GROUP 4 Differences between urban and rural schools. Social context is more important in urban schools. Differently from other countries, Colombian teachers significantly refer to books as a source of teaching stimuli (similar in Argentina). Digna suggests this might be a question of how the profession is perceived in the country, more theoretical professions (< - > books) being more valued than practical ones. But what books are we talking about? Colombia: the academic books used during training. Teachers in all countries value critical thinking, but what does each teacher actually mean? GROUP 6 Content seems to be more important here. But maybe that's because primary schools were not taken into account in the survey.	GROUP 1 Suggests to promote exchange of experiences and materials among teachers
Other issues (use all space necessary) GROUP 2: what about practical issues in argentine. GROUP 3: hard to draw conclusions on the FA from the questionnaire results GROUP 4: very interesting differences among the three geographic areas covered in the survey. How are international (standardized) learning surveys perceived? In Colombia they seem to represent an opportunity to frame their work in projects. What is the standardized vision of science competence? Does it apply to cultures as different as UK, Sweden, Spain, Italy, Brazil, Colombia? Do international surveys just make teachers comply to the tests? To a particular vision of science competence?	

SPAIN: many differences between primary and secondary school teachers. Primary school teachers feel they need more training, because they are not specialized. Secondary school teachers, don't feel they have to be trained more, even in educational/pedagogical competences. We expect involving the entire school in a FA is feasible in primary school. In secondary, it would be a big result to be able to involve the whole science department. Even the science department is divided in two branches that hardly talk to each other.
Instability of teacher staff in schools (Spain, Italy,
Hard to identify what teachers understand as research
Science is not mandatory in the last three grades in Spain and Israel.
In Argentina bilingual teachers are to couple with Spanish speaking teachers to teach in indigenous schools.
In Colombia, teachers teaching in indigenous schools have to speak the indigenous language.