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How French Students Meet the Environmental Challenges?

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ABSTRACT

Whilst the science education for the 21st century is meant to foster an engagement and an understanding of science in society and environmental problems, there is a need to examine those aspects and issues that are relevant (major issues, role of scientists and experts, role of the future...). However, little attention was paid to these concerns in the curriculum. Yet, young people's views of the future reflect the sociopolitical concerns of the time (Hicks, 1996). In the present article, the purpose is to document to what extent students do agree with the statements about some environmental challenges (pollution, overuse of resources, global changes of the climate, future...) with a data from a questionnaire-based study involving students attending secondary school in France. This study forms part of a wider international survey, the Relevance of Science Education (ROSE) project, based at the University of Oslo. Our result show that French students are interesting in learning about pollution of water and air, but are not interesting in learning about practices that limit the effects of pollution and pesticides. Students seem to be unaware of the causal chain that is at the origin of pollution. Lange (2012) ensures the contribution of science partially to equip the citizen for democratic deliberation within particular contexts. However, environmental knowledge can be uncertain. This doubt maintains the democratic potential of the environmental issues, arousing controversies which are the lifestyle choices and the choices of society. Given these findings, we have to help students to build a relationship to the environment, more relevant on social and personal level, with more informed and located knowledge. A relationship renewed between humans and environment based on integrated designs of the future.

KEYWORDS
gender, secondary schools, relationship to the environment, the Relevance of Science Education Project, engaging young people with environmental challenges

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Introduction

Prompted by international concerns about school science education, a steady stream of reports, inquiries and commentaries share a commitment to the curriculum deemed essential for the 21st century, including citizens' decision-making around social, ecological and personal issues. Some have been issued or commissioned by governments and other organizations at national and

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international level (e.g., AAAS 1989, 1993; Assemblée Nationale, 2006; European Commission 2004, 2009; House of Lords, 2006; National Research Council 1996, 2013) or initiated by individual science educators (e.g., Hurd 1986, 2002; Millar and Osborne, 1998). Most have been prompted by issues of national concern (e.g., Académie des sciences, 2004; Assemblée Nationale, 2006; Dercourt, 2004; Kalali, 2010; Thélot, 2004). The real challenge for many countries is still to develop an informed citizenship as well as to require that all students receive an education in science. Such *universal* science education is meant to enable students to build a consistent representation of the world in which they live and to answer simply but carefully some scientific and civic questions (e.g., how the world is created, what is my place, my responsibility...?). We can see a dual prospective vision through a many of these publications that have sought to redefine school science education in these ways. The first one is personal, preparing young people as future citizen to meet the challenges that they will face as adults in their lives. The second is more global: it sought to promote a common core of knowledge, competencies and values considered crucial for the 21st century. Hicks observes (1996):

Yet, if children are the citizens of the 21st century, it is the images that they have now which will influence their aspirations for that future. It would seem imperative, therefore, that more attention be paid to the images of the future that young people already have and to the sort of education that is needed to prepare them more effectively for the future (p. 1).

The concept of the future interested educators in the environmental and scientific fields. Whilst the science education for the 21st century is meant to foster an engagement and an understanding of science in society and environmental problems, there is a need to examine those aspects and issues that are relevant (major issues, role of scientists and experts, role of the future...). However, little attention was paid to these concerns in the curriculum. Yet, young people's views of the future reflect the sociopolitical concerns of the time (Hicks, 1996). Probably, media and scientists while they focus on some issues like pollution or climate change suggest that it's a real concern for all society and the world. Eckersley (1994) had attest, as suggested by studies, that global environmental destruction is in a deepening concern of young people. From the two perspectives above, school science education linked in a various way to a citizenship becomes inseparable from the challenges that shape our society such the environment. It allows students to address broad issues not strictly scientific and led young people to discuss with experts and equip them to act (Host, 1985) as Hicks assert about engaging students with environmental challenges, we have to allow them "to see themselves as potentially proactive rather than merely reactive to change" (1996, p. 12).

Therefore, science education can contribute to the education for sustainable development (ESD) (Lange, 2012) or the environmental education. Scientific methods and knowledge can be a support of ESD for example. In return, dealing with environmental issues allows reducing the gap between science and daily life, and can express some relevance for students.

In French context of the curriculum reforms, the environmental education has been shaped through a big change from 1977 -biocentric approach- to 2011-

sociocentric approach- [Asloum and Kalali, 2013]. In the curriculum of 1977, we had typically an educational and environmentalist biocentric perspective. Nature here was considered as an element to be preserved, centered on the conservation of species. When environmental education for sustainable development was substituted to environmental education, first in 2004, the former becomes a tool for environmental management. Environment was placed at the intersection of social and natural systems that stresses the idea of human interaction with nature. We can see a technocentric approach in 2004. Here, environment is defined as a set of limits, of problems to be solved. It manages risks that can operate as systems. In 2007 and 2011, the environment was more focused on social systems (Groups of individuals like Eco citizens). It was also focused on local societies and their sociocultural context (MEN, 2007 & 2011).

Sauvé (1998) proposes to define the environment broad enough to cover different designs. The environment can be seen as:

- an “Environment problem”, which is threatened by pollution, acid rain...;
- an “Environment resources” which is managed, used and exploited in a perspective of sustainable development and equitable sharing;
- an « Environment nature », which is pure, and original source of respect and admiration, that must be preserved and which we must be reconnected with;
- an « Environment biosphere », which is the Earth, a living planet;
- an “Environment habitat », that is the life of every day, at home, at school, at work, during leisure, that we need know and manage;
- an “environmental community”, shared by a human community, in which we must become involved in order to participate in its evolution.

Different aspects of the environment are therefore taken into account. Within particular contexts, the environment can be seen at some levels as human, natural, economic, social, cultural, political, technological, or ethical. According to the importance of the values, judgments or knowledge and the convergence of the various aspects seen above, the environmental education will be more ethical, conceptual and cultural or social. This debate lays the possibility to reach a consensus based on the idea of «environmental citizenship" (Cohen, 1989; Bowers, 2001). It means built an interdependent and responsible relationship between the human beings and the natural environment (Boutet, 2003):

- being conscious of its empowerment to act;
- engaging in the protection of the environment;
- practicing critical thinking to understand the socio-political and ethical issues related to any environmental action;
- developing the capacity of democratic participation to act with others.

Purpose

In the present article, the purpose is to document to what extent students do agree with the statements about some environmental challenges (pollution,

overuse of resources, global changes of the climate, future) with a data from a questionnaire-based study involving students attending secondary school in France. This study forms part of a wider international survey, the Relevance of Science Education (ROSE) project, based at the University of Oslo. Details of the questionnaire (Schreiner and Sjøberg, 2004) and information about the countries involved can be found in Sjøberg and Schreiner (2010) or on the project Web site (roseproject.no). These sources examine a range of technical and methodological issues, including the rationale, design, piloting and deployment of the ROSE questionnaire, reliability, validity and credibility, and the limitations of a Likert-type scale. The reader is referred to these resources for the necessary details.

The different approaches (biocentric, technocentric and sociocentric) referred to above represent the French response to the global challenges and recommend that schools train young people to function as individuals, as future citizens, and as future professionals. This notion of a "multi-faceted" student has proved to be politically contentious. The aim of ROSE-instrument is to map out affective perspectives on science, technology and environment in education as seen by 15 year old learners. It taps into the diversity of interests, experiences, priorities and attitudes that young people in different countries bring to school (or have developed at school) and the findings add a civic dimension to debates about curricular choices and priorities (Schreiner & Sjøberg, 2004). Some earlier studies of the "student voice" (Jenkins 2006) have focused on students' interests in, or attitudes towards, science and scientists (e.g., Lehrke and al., 1985; Gardner, 1975; Tamir and Gardner, 1989; Schibeci, 1984), other work has complemented this core of studies by redirecting research at exploring more directly on what students think about their school science education (e.g., Osborne & Collins, 2001) and on the role of science and technology in society and on scientific and technological developments (Eckersley 1999). Hicks & Holden (1995) explored the relationship between students' attitudes about the role of science in society and their sense of optimism about the future, a relationship that is also of interest to researchers in the field of citizenship education (Hicks & Holden, 2007). The affective perspectives are often trivialized to mean positive attitude, experiences and are stated as learning outcomes in themselves (Schreiner & Sjøberg, 2004). Attitudes in ROSE project are rather seen as support of some sorts of science, some sorts of environmental issues; and oppose and discourage other (Schreiner & Sjøberg, 2004).

Method

The ROSE questionnaire was piloted in a number of national and international preliminary studies in countries that necessarily differed historically, culturally, socially, economically and politically. The complete validated ROSE questionnaire invites students to respond using a four-point Likert-type scale to a series of closed items covering several different aspects of science, technology, environment and science education. The target population is students aged 15. Three of the sections invite students to answer to a series of statements about "what they would like to learn". Other sections are "My future job", "Me and the environmental challenges", "My science classes", "My opinion about science and technology", and "My out-of-school experiences". The one open question asks students "What I would do as a scientific researcher". The research reported here is based on students' responses to the 18 statements of the questionnaire entitled "Me and the environment challenges" with a 4-point Likert

scale from “Disagree” to “Agree”. For examples: **“**Threats to the environment are not my business”, “I can personally influence what happens with the environment”, “Environmental problems should be left to the experts”, “I am optimistic about the future”. The statements 1-14 were inspired by the literature relating to “alienation, powerlessness meaninglessness and normlessness (e.g., Seeman, 1972)... The remaining four items were developed to examine students’ quasi religious view on nature and protection of nature as a goal in itself (statements 15, 17, 18) and of nature as sacred (statement 16)” (Schreiner & Sjøberg, 2004, p.66).

A Likert scale was chosen in favour of other attitude scales like Thurstone scales. The limitations of such tool are given in the ROSE documentation and are also well-described (Cohen et al. 2000; Aikenhead and Ryan, 1992). The latter have shown that differences in understanding the items on the part of the researcher and the respondents can generate ambiguities which affect the interpretation of the scores. Nevertheless, the Likert-type scale, through the calculation of averages, remains a convenient way of exploring the answers given by the sample of students although it can indicate nothing about the attitude of an individual student (Gardner, 1995).

This consists of explore to what extent the students feel concerned to cope with the environmental problems. The present research addresses the following questions.

- How do students relate to environmental challenges?

- Are there any significant gender differences in the students’ responses?

- Are there any significant area differences between the two academies Paris and Créteil?

The results of section D are crossed with some of the 108 items of sections A, C, E "what they would like to learn" especially those are linked to environmental subjects.

Sample

The target population concerned with ROSE is pupils aged 15. Since 1975, French pupils aged from 11 to 15 have followed the same syllabus in a single school (*collège unique*) regardless of any social diversity among the intake. The sample on which this study is based was drawn in 2008-2009 from 2,395 students in Year 9 attending schools in Paris and Créteil in the *région Francilienne* which constitutes about one tenth of the total number of comparable schools in metropolitan France. According to Dercourt (2004), this region can be taken as reasonably representative of metropolitan France as a whole and is unlikely to introduce significant distortions either in the sampling or the subsequent analysis. The sample of schools was determined in meetings with the relevant inspectors and took account of differences in school structure, pupil intake, staffing etc. Questionnaires were sent by the responsible authorities to the two *académies*[i] of Paris and Créteil. We had translated the questionnaire from English to French and the authorities of our laboratory validate it. Then a first version was tested before. The questionnaires were sent by academic inspectors and distributed to a class chosen at random by the Director within each school. Sampling thus targeted all the schools that form the *académie* of Paris. A total of

1,289 questionnaires were wholly completed from 61 schools with a gender ratio of 713 girls to 576 boys. Identification of the individual schools that participated in the research showed that they were divided evenly between the 20 *arrondissements* that make up the city of Paris. In Créteil, the schools sampled were distributed so as to reflect the geographical diversity of the Department. Overall, 53 of 60 target schools (about 1,106 students; 551 girls, 555 boys) responded to the ROSE questionnaire.

The 2,395 students' responses were coded in our laboratory and analyzed by the researcher in accordance with the procedure laid down by the ROSE Project in Oslo. Their treatment was made in SPSS as recommended by the Norwegians of the project managers and sent to University of Oslo. Our analytical procedures are based on measure of the mean and standard deviation (S.D.) of each item in section D or section ACE. The middle point of the scale corresponds to 2.5. The means of boys and girls or of Paris and Créteil area distributions have been compared by using the Independent-samples T-test. And as an additional check, we add Cohen's measures d (1988) the effect size for the differences by gender and by area (no effect at d <0.2▪; small effect at 0.2≤d<0.5□; moderate effect at 0.5≤d<0.8; and large effect at d ≥0.8). We also check the Principal of Component Analysis (ACP) of the responses by gender for girls and boys and by area for Paris and Créteil. In order to ensure that such an analysis could be applied appropriately to the responses to Section D and ACE, it was first established that none of the items had a correlation coefficient less than 0.20. Principal of Component Analysis was shown to be relevant to the analysis following testing using the Kaiser-Mayer-Olkin and Bartlett sphericity procedures. To evaluate the internal consistence of some groups of items, we calculate Cronbach's Alpha (α) for each group.

Results

The French students' responses to the eighteen statements in the section "Me and the environmental challenges" of the ROSE questionnaire are given in table 1. Gender differences and differences between the responses of students in the two sample areas in these responses, with an indication of their statistical significance (Independent-Sample t-test and Cohen's d measure), are given in table 2 and 3 respectively.

Descriptive statistics and statistical significance

Table 1. French students' responses to section D "Me and the environmental challenges"

Statement	1 Strongly Disagree	2 Disagree	3 agree	4 Strongly Agree	Nil Response	Mean	S.D.
1. Threats to the environment are not my business	60.5%	28	9.8	0	1.7	1.68	1.038
2. Environmental problems make the future of the world look bleak and hopeless	18.1	22	23.8	33.7	2.5	2.74	1.128
3. Environmental problems are exaggerated	40.6	26.3	17	14.4	1.6	2.07	1.109
4. Science and technology can solve all environmental problems	37	30.4	17.6	11.6	2.3	2.06	1.044
5. I am willing to have environmental problems solved even if this means sacrificing many goods	19.2	24.1	26.8	27.1	2.8	2.63	1.112
6. I can personally influence what happens with the environment	28	24	22.1	23.1	2.8	2.44	1.176
7. We can still find solutions to our environmental problems	7.7	9.4	23.5	58.1	1.3	3.33	.967

8. People worry too much about environmental problems	49.1	24.6	12.2	12.5	1.6	1.90	1.113
9. Environmental problems can be solved without big changes in our way of living	29.4	25	21.3	22.3	2.1	2.37	1.160
10. People should care more about protection of the environment	8.5	12.4	24.4	53.2	1.5	3.26	1.001
11. It is the responsibility of the rich countries to solve the environmental problems of the world	15.4	18.2	26.2	38.4	1.8	2.91	1.111
12. I think each of us can make a significant contribution to environmental protection	9.5	14.3	23.6	49.5	3.5	3.16	1.027
13. Environmental problems should be left to the experts	49	26.9	11.4	11	1.7	1.85	1.037
14. I am optimistic about the future	18.5	26.3	25.8	26.8	2.6	2.63	1.105
15. Animals should have the same right to life as people	19	18.5	21.2	38.2	3.1	2.80	1.184
16. It is right to use animals in medical experiments if this can save human lives	31.8	26.5	19.8	19.1	2.8	2.28	1.149
17. Nearly all human activity is damaging for the environment	30.4	30.1	22	14.5	3	2.22	1.077
18. The natural world is sacred and should be left in peace	10.9	17.6	25.8	43.1	2.7	3.04	1.082

The data (Table 1) make it clear that 60.5% [mean 1.68; S.D 1.038] of boys and girls disagree strongly with the statement that "Threats to the environment are not my business". Such concern lies clearly among other priorities (Statements 3, 8, and 13) respectively: 40.6% [mean 2.07; S.D 1.109] of boys and girls disagree also strongly with the statement that « Environmental problems are exaggerated »; 49.1% [mean 1.90; S.D 1.113] of students disagree strongly that "People worry too much about environmental problems" and 49% [mean 1.85; S.D 1.037] disagree strongly that "Environmental problem should be left to the experts". These negatively worded items seem to have in common a *lack of concern* for the environmental issues (Schreiner & Sjøberg, 2005). Our results suggest a great concern for environmental challenges. 29.4% [mean 2.37; S.D 1.160] of students disagree strongly with supporting solutions to environmental problems "without big changes in our ways of living" (Statement 9), while only 19.2% of students [mean 2.63; S.D 1.112] disagree strongly with "sacrificing many goods" in order to walling to have environmental problems solved (Statement 5). The solution to such problems, for our students, is a big change in lifestyle rather than modification of consumption.

Some positively worded items (Statements 5, 6, 7, 10 and 12) are describing a personal *involvement* in the issue (Schreiner & Sjøberg, 2005). Our data (Table 1) are in the line with this tendency: 58.1% [mean 3.33; S.D .967] are optimistic about finding solutions to our environmental problems (Statement 7).

Table 2. French students' responses by gender to section D "Me and the environmental challenges"

Statement	Mean S.D. girls	Mean S.D. boys	t	p	d
1. Threats to the environment are not my business	1.63 1.012	1.74 1.065	-2.849	.004	-0.10▪
2. Environmental problems make the future of the world look bleak and hopeless	2.76 1.104	2.73 1.151	.688	.491	0.02▪
3. Environmental problems are exaggerated	2.04 1.103	2.09 1.112	-.260	.795	-0.04▪
4. Science and technology can solve all environmental problems	1.90 .961	2.24 1.105	-7.957	.000	-0.33▪
5. I am willing to have environmental problems solved even if this means sacrificing many goods	2.63 1.073	2.64 1.155	-.506	.631	-0.00▪
6. I can personally influence what happens with the environment	2.44 1.157	2.43 1.200	.448	.654	-0.00▪

7. We can still find solutions to our environmental problems	3.39	3.28	2.449	.014	0.11▪
	.905	1.021			
8. People worry too much about environmental problems	1.82	1.98	-3.546	.000	-0.14▪
	1.099	1.122			
9. Environmental problems can be solved without big changes in our way of living	2.40	2.34	1.243	.214	0.05▪
	1.164	1.155			
10. People should care more about protection of the environment	3.32	3.19	3.697	.000	0.12▪
	.969	1.028			
11. It is the responsibility of the rich countries to solve the environmental problems of the world	2.85	2.99	-2.931	.000	-0.12▪
	1.117	1.100			
12. I think each of us can make a significant contribution to environmental protection	3.23	3.09	3.058	.002	0.13▪
	1.008	1.043			
13. Environmental problems should be left to the experts	1.72	2.00	-5827	.000	-0.27▪
	.985	1.075			
14. I am optimistic about the future	2.62	2.65	.033	.974	-0.02▪
	1.098	1.113			
15. Animals should have the same right to life as people	2.84	2.74	2.182	.029	0.08▪
	1.187	1.180			
16. It is right to use animals in medical experiments if this can save human lives	2.10	2.49	-7.923	.000	-0.34□
	1.080	1.186			
17. Nearly all human activity is damaging for the environment	2.18	2.26	-1.134	.257	-0.07▪
	1.041	1.117			
18. The natural world is sacred and should be left in peace	3.11	2.96	3.522	.000	0.46□
	1.042	1.117			

* p <0.05 significant

The means of the boys' and girls' distributions have been compared using the Independent-Samples t-test and as an additional check, we tested the power of the difference using Cohen's d (as d=Mg-Mb/S.D. pooled; S.D. pooled = $\sqrt{[S.Dg^{\ 2} + S.Db^{\ 2}/2]}$ (Cohen, 1988). The Independent-Samples t-test procedure compares means for two groups of cases. Cohen's d measures the effect size for the difference between boys and girls: no effect at d <0.2▪; small effect at 0.2≤d<0.5□; moderate effect at 0.5≤d<0.8; and large effect at d ≥0.8

The data in table 2 show that the gender's factor has a significant impact on the responses to 11 of 18 statements. However, girls as boys are optimistic about future (mean girls 2.62; SD 1.098/mean boys 2.65, SD 1.113). This statement 14 about future must be put in opposition with the statement 2 "Environmental problems make the future of the world look bleak" (mean girls 2.76; S.D 1.104/mean boys 2.73; S.D 1.151). Statement 14 may reflect the personal (and not environmental) optimism for the future; in this case our students are slightly optimistic. Yet the statement 2 shows bleak future of the world for our students boys as girls. These results are in line with earlier surveys that showed optimism over personal future but pessimism over global future (Hicks et Holden, 1995; Hicks, 1996). In line with the result of statements 2 and 14, both of girls and boys are neutral about statement 6 "I can personally influence what happens with the environment". This degree of confidence might be related to the fear for the future of the world and contrasted with the strong agreement for more girls than boys about collective contribution to environmental protection (statement 12); about finding solutions to environmental problems at collective level (statement 7).

The data make it a clear gender differences about environmental problems that can "be left to the experts" (statement 13) and about statement that "science and technology can solve all environmental problems" (statement 4), with girls more skeptical than boys. These differences are significant (< 0.05). Two-thirds of the students do not adhere to proposal 17 "almost all human activity is harmful to the environment" while more girls than boys find "the natural world is sacred, it should be left in peace" (statement 18). In the two proposals," nature" and "environment" have not the same status. Nature seems to be often designed as a something given, while the environment is of the order to be built.

The data in table 3 show that the area's factor has not a significant impact on the responses of students from Paris and Créteil. All students reject statements 1, 8 and 13 (Means <2.5). They feel concerned with environment and its problems that should not be left only to the experts. Students from Paris and Créteil share also optimism about future, their future and the future of world. However we have one difference about statement 12. Students from Paris think strongly that each of us can make a significant contribution to environmental protection (Mean 3.18/S.D 1.033) while students of Créteil reject this (Mean 1.13/S.D 1.019). This reject contrast with their response to the statement 5 (Mean of Créteil is >2.5).

Table 3. French students' responses by académie to section D "Me and the environmental challenges"

Statement	Mean **S.D** Paris	Mean **S.D** Créteil	t	p	d
1. Threats to the environment are not my business	1.72 **1.101**	1.63 **.951**	1.218	.223	0.08▪
2. Environmental problems make the future of the world look bleak and hopeless	2.72 **1.141**	2.77 **1.112**	-.943	.346	-0.04▪
3. Environmental problems are exaggerated	2.07 **1.140**	2.06 **1.068**	-.524	.600	0.00▪
4. Science and technology can solve all environmental problems	2.08 **1.063**	2.04 **1.020**	1.267	.205	0.03▪
5. I am willing to have environmental problems solved even if this means sacrificing many goods	2.66 **1.147**	2.60 **1.067**	1.006	.314	0.05▪
6. I can personally influence what happens with the environment	2.48 **1.194**	2.39 **1.152**	1.920	.055	0.07▪
7. We can still find solutions to our environmental problems	3.33 **1.983**	3.32 **.947**	.237	.813	0.00▪
8. People worry too much about environmental problems	1.93 **1.169**	1.86 **1.035**	.714	.475	0.06▪
9. Environmental problems can be solved without big changes in our way of living	2.35 **1.177**	2.39 **1.139**	-1.168	.243	-0.03▪
10. People should care more about protection of the environment	3.27 **1.025**	3.24 **.971**	.464	.643	0.03▪
11. It is the responsibility of the rich countries to solve the environmental problems of the world	2.97 **1.127**	2.84 **1.087**	3.405	.001	0.11▪
12. I think each of us can make a significant contribution to environmental protection	3.18 **1.033**	1.13 **1.019**	1.242	.214	0.04▪
13. Environmental problems should be left to the experts	1.87 **1.061**	1.82 **1.005**	1.160	.246	0.04▪
14. I am optimistic about the future	2.67 **1.138**	2.58 **1.061**	1.598	.110	0.08▪
15. Animals should have the same right to life as people	2.76 **1.211**	2.85 **1.147**	-2.230	.042	-0.07▪
16. It is right to use animals in medical experiments if this can save human lives	2.33 **1.172**	2.23 **1.116**	2.030	.042	0.08▪
17. Nearly all human activity is damaging for the environment	2.22 **1.113**	2.21 **1.030**	.624	.533	0.00▪
18. The natural world is sacred and should be left in peace	2.99 **1.146**	3.09 **.991**	-2.116	.634	0.09▪

* p <0.05 significant

The means of students of Paris (p) and Créteil (c) distributions have been compared using the Independent-Samples t-test and as an additional check, we tested the power of the difference using Cohen's d (as d=Mp-Mc/S.D. pooled; S.D. pooled = $\sqrt{[S.Dp^{\ 2} + S.Dc^{\ 2}}/2]$ (Cohen, 1988). The Independent-Samples t-test procedure compares means for two groups of cases. Cohen's d measures the effect size for the difference between Paris and Créteil: no effect at d <0.2▪; small effect at 0.2≤d<0.5□; moderate effect at 0.5≤d<0.8; and large effect at d ≥0.8

Principal factor analysis

Tables 4 and 5 present the results of a principal component analysis by gender of the responses for boys and girls respectively. Tables 6 and 7 present the results of a principal component analysis by area of the responses for Créteil and Paris respectively.

Table 4. Principal Component Analysis by gender: boys

Statement	Component 1	Component 2	Component 3
1. Threats to the environment are not my business	.085	.720	-.150
2. Environmental problems make the future of the world look bleak and hopeless	.527	.356	-.428
3. Environmental problems are exaggerated	.100	.699	.238
4. Science and technology can solve all environmental problems	.264	.435	.120
5. I am willing to have environmental problems solved even if this means sacrificing many goods	.596	.114	.266
6. I can personally influence what happens with the environment	.566	.065	.245
7. We can still find solutions to our environmental problems	.632	.184	.154
8. People worry too much about environmental problems	.024	.697	.215
9. Environmental problems can be solved without big changes in our way of living	.283	.429	.353
10. People should care more about protection of the environment	.729	.001	.126
11. It is the responsibility of the rich countries to solve the environmental problems of the world	.602	.228	.018
12. I think each of us can make a significant contribution to environmental protection	.664	-.005	.214
13. Environmental problems should be left to the experts	.117	.737	.153
14. I am optimistic about the future	.246	.253	.666
15. Animals should have the same right to life as people	.529	.146	-.002
16. It is right to use animals in medical experiments if this can save human lives	.285	.316	.453
17. Nearly all human activity is damaging for the environment	.450	.421	-.048
18. The natural world is sacred and should be left in peace	.590	.164	.037

Rotation Method: Varimax with Kaiser Normalization.
The Analysis identified three main factors for boys: the percentage of variance is 29,7%; 10,31% ; 5,6%.

Table 5. Principal Component Analysis by gender: girls

Statement	Component 1	Component 2	Component 3
1. Threats to the environment are not my business	-.028	.086	.692
2. Environmental problems make the future of the world look bleak and hopeless	.549	-.287	.382
3. Environmental problems are exaggerated	-.004	.241	.642
4. Science and technology can solve all environmental problems	.177	.112	.482
5. I am willing to have environmental problems solved even if this means sacrificing many goods	.567	.105	.175
6. I can personally influence what happens with the environment	.578	.179	-.012
7. We can still find solutions to our environmental problems	.588	.133	.110
8. People worry too much about environmental problems	-.075	.546	.475
9. Environmental problems can be solved without big changes in our way of living	.198	.501	.137
10. People should care more about protection of the environment	.762	.053	-.113
11. It is the responsibility of the rich countries to solve the environmental problems of the world	.531	.157	.146
12. I think each of us can make a significant contribution to environmental protection	.590	.311	-.198
13. Environmental problems should be left to the experts	.008	.605	.417
14. I am optimistic about the future	.162	.580	.084
15. Animals should have the same right to life as people	.446	.361	-.060
16. It is right to use animals in medical experiments if this can save human lives	.227	.496	.186
17. Nearly all human activity is damaging for the environment	.319	.536	.023
18. The natural world is sacred and should be left in peace	.511	.357	.054

Rotation Method: Varimax with Kaiser Normalization.

The Analysis identified three main factors for boys: the percentage of variance is 24,1% ; 11,36% ; 6,03%.

The responses of boys (table 4) and girls (table 5) about the first component are not marked by gender. Data bunching around statements (2, 5, 6, 7, 10, 11, 12 and 18) present a group of students who have the hope for future, feeling that they can influence what happens with environment, consciousness that is important

for society. How they know that they can act? We don't have the possibility to know, excepting for statement 5.

About Boys (table 4), the first component shows the contribution of statements 2, 5, 6, 7, 10, 11, 12, 15 and 18. These statements are linked with the individual and social involvement towards action against problems of the environment. It contrasts with the sacredness of nature. The second component shows that the statements 8 and 13 are correlated to statements 1 and 3. The feeling of an exaggeration of the problems of environment and the excessive costs of social concern is related to increased confidence in the experts whom must be in charge of these problems. The third component shows that statement 14 is the unique contributor. Optimism does not necessarily enable involvement towards the action for the benefit of the environment.

Among girls (table 5), the first factor is the same as revealed for boys. These two groups show an involvement towards action against problems of the environment which seems not related to optimism. The second factor shows that statements 8 and 13 are correlated to the statements (14, 17 and 9), but they are not correlated to statement 1. This means a personal commitment different for girls than boys (statement 1). This commitment is possible for girls despite the feeling of great social concern for environmental problems or confidence in the experts. Among girls, the optimism combined with the belief in the harmful effect of all human activity makes the difference. They do not believe, unlike boys, that the problems are exaggerated. The third factor shows two contributors statements 1 and 3. Individual disengagement is related to the feeling of an exaggeration of the environmental problems which seems exonerate students of a personal involvement. The responses of girls (third component) and boys (second component) present a different group of students around statements 1, 3, 8 and 13 who are not motivated for action because environment problems are exaggerated, produce fear and should be left to the experts.

In table 6 and table 7, the Analysis identified three main factors for Créteil and Paris. The percentage of variance for Créteil is 23%; 10,7% ; 5,6%. For Paris the percentage of variance is 29, 97; 11, 25%; 5, 8%. Given answers from students, both academies have a low contrast. A both academies show a grouping of statements (factor 1) that mark a commitment to solve environmental problems. It will be noted among students of Créteil a less individual involvement (statement 6) compared to the students of Paris and pessimism about the future (statement 2).

The results seem to oppose individual and collective responsibility (countries, experts, society), while the environment seems to be rather collective than individual.

Table 6. Principal Component Analysis by area: Créteil

Statement	Component 1	Component 2	Component 3
1. Threats to the environment are not my business	.069	.676	.015
2. Environmental problems make the future of the world look bleak and hopeless	.606	.224	-.281
3. Environmental problems are exaggerated	.088	.691	.068
4. Science and technology can solve all environmental problems	.168	.509	-.013
5. I am willing to have environmental problems solved even if this means sacrificing many goods	.490	.195	.229

6. I can personally influence what happens with the environment	.462	-.014	.323
7. We can still find solutions to our environmental problems	.589	.144	.150
8. People worry too much about environmental problems	-.104	.612	.337
9. Environmental problems can be solved without big changes in our way of living	.252	.414	.199
10. People should care more about protection of the environment	.703	-.104	.096
11. It is the responsibility of the rich countries to solve the environmental problems of the world	.568	.222	.010
12. I think each of us can make a significant contribution to environmental protection	.524	-.055	.317
13. Environmental problems should be left to the experts	-.009	.661	.314
14. I am optimistic about the future	.147	.203	.528
15. Animals should have the same right to life as people	.429	.055	.208
16. It is right to use animals in medical experiments if this can save human lives	.113	.156	.642
17. Nearly all human activity is damaging for the environment	.326	.181	.474
18. The natural world is sacred and should be left in peace	.439	.062	.403

Rotation Method: Varimax with Kaiser Normalization.

Table 7. Principal Component Analysis by area: Paris

Statement	Component 1	Component 2	Component 3
1. Threats to the environment are not my business	-.023	.729	-.038
2. Environmental problems make the future of the world look bleak and hopeless	.488	.470	-.400
3. Environmental problems are exaggerated	.038	.640	.298
4. Science and technology can solve all environmental problems	.273	.473	.053
5. I am willing to have environmental problems solved even if this means sacrificing many goods	.642	.104	.073
6. I can personally influence what happens with the environment	.637	.054	.138
7. We can still find solutions to our environmental problems	.627	.154	.134
8. People worry too much about environmental problems	.034	.631	.390
9. Environmental problems can be solved without big changes in our way of living	.276	.229	.567
10. People should care more about protection of the environment	.789	-.011	.053
11. It is the responsibility of the rich countries to solve the environmental problems of the world	.590	.212	.083
12. I think each of us can make a significant contribution to environmental protection	.738	-.059	.200
13. Environmental problems should be left to the experts	.130	.621	.386
14. I am optimistic about the future	.250	.155	.683
15. Animals should have the same right to life as people	.540	.073	.254
16. It is right to use animals in medical experiments if this can save human lives	.289	.317	.462
17. Nearly all human activity is damaging for the environment	.408	.324	.249
18. The natural world is sacred and should be left in peace	.590	.155	.190

Rotation Method: Varimax with Kaiser Normalization.

How interested are French students in learning/experiencing about the environmental challenges? For this suppose, we will examine the responses of the same sample of students to another section of the ROSE questionnaire. In this section, students were invited to indicate in a four-point scale what they "want to learn about": "The origin and evolution of life on earth", "Eating disorders like anorexia or bulimia", "Astrology and horoscopes, and whether the planets can influence human beings". Some others items include many that are linked with environmental issues. We obtained 4 groups of items (table 8 to 11). To evaluate the internal consistence of groups of items, we calculate Cronbach's Alpha (α) for

each group. Each table shows the mean M of the items and separate means for boys Mb and girls Mg as well as standards deviations S.D. g and S.D. b. The middle point of the scale is 2.5, neutral. Consequently, it is possible to conclude that when the mean falls below 2.5, the majority of students are not interested in the subject matter. When the mean is above 2.5, the majority of students are interested. The means of boys and girls have been compared using the Independent-Samples t-test. This procedure compares means for two groups of cases.

Some items indicate crucial environment problems (table A). These statements underline the concern with pollution of air and water, effect of the ozone layer, problems of waste and the greenhouse.

Table 8. Crucial environment problems (M = 2.42, α =.798)

Item	Girls Mean **S.D.**	Boys Means **S.D.**	t	p	d
E3. The ozone layer and how it may be affected by humans	2.33 **1.098**	3.43 **1.141**	-2.095	.036	-0.98
E4. The greenhouse effect and how it may be changed by humans	2.19 **1.076**	2.31 **1.106**	-2.661	0.008	-0.11▪
E5. What can be done to ensure clean air and safe drinking water	2.69 **1.069**	2.64 **1.081**	1.214	.225	0.04▪
E6. How technology helps us to handle waste, garbage and sewage	2.32 **1.062**	2.49 **1.102**	-3.833	0.000	-0.15▪

* p <0.05 significant

Cohen's d measures the effect size: no effect at d <0.2▪; small effect at 0.2≤d<0.5□; moderate effect at 0.5≤d<0.8; and large effect at d ≥0.8

Among the four items (table 8), students are interested in what can be done to ensure clean air and water. They are less interested in learning about greenhouse effect and ozone layer (except for boys, statement E3). We can suggest that for the former, the risk seems be more apparent. The strong media coverage in both public and scientific spheres allows understanding this interest compared to the disinterest of students about greenhouse effect and ozone layer. The former appear more local. There's perhaps a "proximity effect" of these problem of pollution that can create a desire to "learn about" in order to "involve with".

Table 9. Biodiversity, natural resources and their safeguarding (M= 2.67, α= .672)

Item	Girls Mean	Girls S.D.	Boys Mean	Boys S.D.	t	p	d
E16. How to protect endangered species of animals	2.81	1.107	2.75	1.116	1.127	.260	0.05▪
E20. How energy can be saved or used in a more effective way	2.50	1.127	2.69	1.104	-3.995	0.000	-0.17▪
E21. How different sorts of food are produced, conserved and stored	2.50	1.128	2.82	1.114	-6.975	0.000	-0.28□

* p <0.05 significant

Cohen's d measures the effect size: no effect at d <0.2▪; small effect at 0.2≤d<0.5□; moderate effect at 0.5≤d<0.8; and large effect at d ≥0.8

Statements in table 9 underline the issues of biodiversity, natural resources and their safeguarding. About the protection of animal species, their extensive use is often related to their overuse as a resource. Boys are more interested in how protect, save, produce, conserve food, energy, species of animals. Girls are more interested in "how to protect endangered species of animals". Girls as boys are

more interested in "how to act" than "how it may be affected". They are in an activism position.

Table 10. Environmental knowledge and awareness of its own area (M= 2.25; α=.699)

item	Girls Mean S.D.	Boys Mean S.D	t	p	d
A16. How people, animals, plants and the environment depend on each other	2.38 1.065	2.31 1.028	1.539	.124	0.06▪
A13. Animals in other parts of the world	2.37 1.127	2.52 1.136	-3.107	.002	-0.13▪
E24. Animals in my area	2.32 1.112	2.31 1.147	.347	.728	0.00▪
E25. Plants in my area	1.90 .987	1.93 1.014	-.736	.462	-0.3□

* p <0.05 significant

Cohen's d measures the effect size: no effect at d <0.2▪; small effect at 0.2≤d<0.5□; moderate effect at 0.5≤d<0.8; and large effect at d ≥0.8

In table 10, the aim is to indicate how French students are interested in learning about environment as subject. If the assumption is that we need sufficient knowledge about environment for making-decision, we can see that the average of means of items falls below 2.5; the majority of students are not interested in these subjects matter.

Table 11. Respect for the natural and organic label (M= 1.89; α= .739)

Statement	Girls Mean S.D.	Boys Mean S.D.	t	p	d
E17. How to improve the harvest in gardens and farms	1.80 .966	1.91 1.046	-2.581	.010	-0.11▪
E19. Organic and ecological farming without use of pesticides and artificial fertilizers	1.93 1.109	1.99 1.069	-1238	.216	-0.05▪
E33. Benefits and possible hazards of modern methods of farming	1.75 .996	1.95 1.073	-4.551	.000	-0.19▪

* p <0.05 significant

Cohen's d measures the effect size: no effect at d <0.2▪; small effect at 0.2≤d<0.5□; moderate effect at 0.5≤d<0.8; and large effect at d ≥0.8

In table 11, statements 17, 19 and 33 present some alternative practices labeled with a core of knowledge about sustainable development. It is interesting to see if students are willing to learn about these topics. All items are rejected. Students seem to be unaware of the link between the pollution of water that is interesting for them (table 8, statement E5) and for example organic farming as an alternative answer to limit the effects of pollution of pesticides.

I assume that the concept of risk and risk apparent (or not) seems to be important. According to the media in the public sphere, specific environment, daily life, students may be more sensitive to some problems perceived as local compared to those who are seen on a global scale (table 8). However it is not easier to prove. Students, for example, are sensitive to words like threat, extinction, pollution, and overuse which may refer both to local and global problems. Is it a subjective perception of risk? Students enroll in the issues of the times in accordance with society. The need "to learn about" seems slender.

Discussion

The ROSE project provides a declarative material from students. So we can reasonably think that there is some gap between this declared attitude and

effective action. Therefore, we need some caution if we want to extract from data some implications and proposals. However the many responses of our students (e.g., Statements 3, 2, 17, 4) are in line with those of all students from developed countries (Sjoberg and Schreiner, 2008). This constancy in the responses of the students cannot be explained by the impact of curricula and educational systems that may be different from one country to another. Indeed, any interacting factors are involved and result from family, society and school with the influence of peers. So we have to consider the learner entirety in its various spheres: work, education, society and citizenship, personal relationships. For example the mean for statement 3 "Environmental problems are exaggerated" is under to 2.5 for students in developed countries in comparison with developing countries. Views of young people reflect the social, cultural and political concerns of the times (Brown, 1984, cited in Hicks, 1969, p.3). In addition, the concepts of environment and nature seem to be not neutral. People can express different relationship to the nature and the environment, and different ways into environmental protection (Cooper & Palmer, 1998). The relationships to nature and environment contribute to some attitudes to act in (not) preserving nature and environment. While the environment is seen like the nature and "we are part of a larger order", people have to "be open to or in tune with the nature" (Taylor, 1989: 384 cited in Cooper and Palmer, 1998: VIII). The nature must be preserved like an heritage. This feeling of "belonging or subordination to nature" (Canguilhem, 1965) contrasts with the attitude of "instrumental reason", for which the solutions to environmental problems are "technical" (Taylor, 1989: 384 cited in Cooper and Palmer, 1998: VIII). These two attitudes contribute to minimize the human action on the environment which may be structuring. Two-thirds of our students disagree with statement 17 "Nearly all human activity is damaging to the environment". Yet, more girls than boys agree with "The natural world is sacred and should be left in peace". The concept of nature seems have a strong emotional charge. In comparison, the survey commissioned by the French minister of environment in 1992 with 4,719 adult people brings some interesting information about the peoples' views on environment. On the support of questionnaire, the result show that the environment is seen equal to the nature for 59% of people while 23% see the environment more linked with people and only 18% find that environment brings together nature and people (Collomb *et al.*, 1993). The environment will be seen as a construct, distinguished from natural world, built in interaction with society which is an integral part.

French environmental education had known a big change in the later reforms and the requirements for learning of the environment had changed in order to meet the challenges of the sustainable development (Asloum and Kalali, 2013). The environment is more focused on social systems and local societies and their sociocultural context. It aims to train responsible citizens in their homes, work, leisure, and in their territories. It's a real challenge that the recent French curriculum of Earth and Life Sciences focus on the action of the human being and his impact on the environment (Ministère de l'éducation nationale, 2005). Nevertheless, the pedagogical approach to guide classroom in this way is not easy. School science education in France has a tradition of focusing mainly on knowledge. Consequently, how integrate values, attitudes and knowledge about the environment? The assumption that we need sufficient knowledge about environment for making-decision is valuable. Our result show that French students are interesting in learning about pollution of water and air, but are not

interesting in learning about practices that limit the effects of pollution and pesticides (tables 8 and 11). Students seem to be unaware of the causal chain that is at the origin of pollution. Girls as boy are more interested in "how to act" than "how it may be affected". Lange (2012) ensures the contribution of science partially to equip the citizen for democratic deliberation within particular contexts, for example Geo physical alea, scientific rationality and quantitative approach are the support of vulnerability perception. In our case, the knowledge about pollution and pollutants (dose-response, exposure time, degrees of harmfulness), the relationship of causality (links between increased risk of certain diseases and exposure to pollution by epidemiological and statistical studies), the systemic approach (source of pollution by urban activity, industry, farming, landfill sites) may be a contribution of science education to the understanding of human action related to pollution and its impact on the environment. However, environmental knowledge can be uncertain (Almeida, 2005). This doubt maintains the democratic potential of the environmental issues, arousing controversies which are the lifestyle choices and the choices of society. Our study shows that the pollution of water and air are the environmental issues seen at a local level. In this sense, the students are more interested in the impact of these problems on them (their lives). The risk seems be more apparent. There's perhaps a "proximity effect" of these problem of pollution that can create a desire to "learn about" in order to "involvement with". When the problem of environment is seen at a global level (e.g., greenhouse effect, ozone...) with a media coverage in both public and scientific levels, students are more sensitive to the human action seen as a notion (table 8). It can be in line with Polak (1973) analysis about health and well-being on social or local scale that is seen through the prism of private and internal (impact on itself), and more global issues that are seen through the prism of external (men action).

In our study, girls as boys are slightly optimistic about future (their future). But they feel that environmental problems make the future of the world look bleak and hopeless. The problem is the failure of vision, an inability to conceive a future able to serve as a source of inspiration for both individuals and society (Eckersley, 1999). We can see also the "realism of the present" which constitute a difficulty to think the future (Julien *et al.*, 2014). We highlight that there is no significant difference between girls and boys (table 2) while surveys often focus on gender differences. Our study shows a gendered result with girls more skeptical about the power of science and technology to solve all environmental problems and the role of experts. The nature of these differences between girls and boys can be documented through studies on attitudes towards/interest on science and technology reviewed by Jenkins (2006). For example, these differences do not influence the level of commitment but may be its nature. The girls more aware to the social aspects see that science does not only solve problems of society, it also raises ethical, social and political problems. And the solutions lie outside science and not in the immediate future (Jenkins, 2004). Some of these differences can be also captured through a vision of the technological future for the boys and an interest for the girls in their own future, the futures of the community and the world (Gidley & Hampson, 2005).

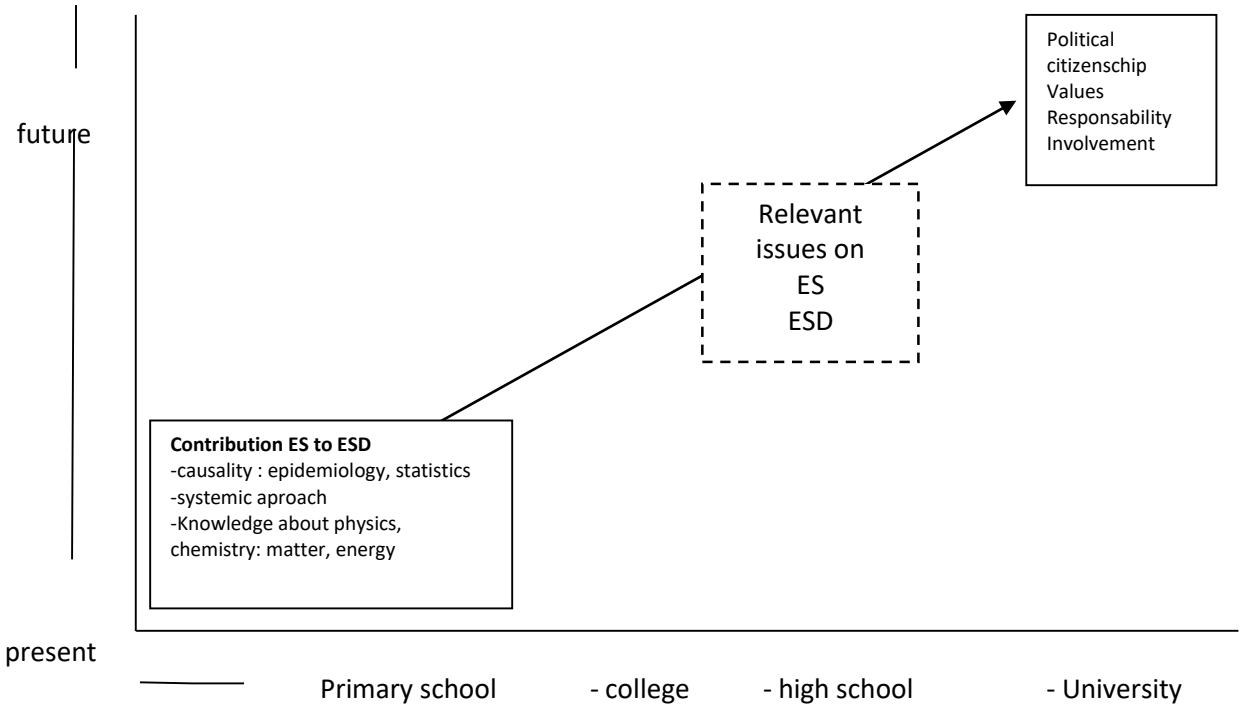
Taking into account the caveats reported above, it's a challenge to play on these tensions in an integrate curriculum at different levels:

- Local: local societies and territories/global: Human societies around the world;

- Past-present-future: as Hicks (1996) recommends, working where there is a gap, a dissonance, between preferable-probable-possible futures for the local and global community. "This, together with case-studies of social change and stories of personal empowerment, allows students to see themselves as potentially proactive rather than merely reactive to change" (Hicks, 1996: 12);

- Bring students to the vision that the environment is placed at the intersection of social systems and natural systems.

We have to help students to build a relationship to the environment, more relevant on social and personal level, with more informed and located knowledge. I assume that the choice of specific situations is highly strategic. In accordance with Condorcet, such situations must allow the knowledge of institutions. The issues must take into account of the policy-making institutions, social actors as well as a reflection on the values. It is a political citizenship which we prefer to that of environmental citizenship. The former is beyond the scope of education to sustainable development and concern also science education. In addition, political citizenship admit empowerment, involvement, understanding of socio-political-ethical issues related to environmental action that Boutet (2003) define for «environmental citizenship"



Graph 1: Citizen scientific education: a modeling contribution of ES to ESD

The terms of future, risk, and causality seem to be very relevant for understanding environmental issues. ROSE shows that the "desire to learn about" environment is slender. Of course, our findings provide a snapshot of what

students think and what are their concern about environment. Those change over time and it may be a limit of our research even today's environmental challenges remain the same. Given these findings, we need research about how improve the contribution of SE to ESD. For example, we apply for more cooperation between environmental, future and science researchers. We need research to renew educational practices and promote school activities that remain in the wake of "doing science". The risk is a self-reference to the scientific discipline that is valued, primarily the reference to the experimental practice of the laboratory which excludes the reference to other socio-scientific practices.

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No potential conflict of interest was reported by the authors.

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[i] In France, an Academy is an administrative district of the Ministry of National Education and the Ministry of higher education and research. Since January 1, 2016, each Academy is part of an academic area (whose borders correspond to those of the administrative regions). Each Academy is headed by a Rector appointed by the Prime Minister, in general among the professors of the universities.