Important but not for me as a girl: French students' attitudes towards secondary school science

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Abstract

While the role of science and technology is extremely important for the contemporary society, while expertise in science and technology has proved to be politically a key issue, western countries have observed a decline in students' interest in both studying and pursuing careers in scientific subject areas. In the present article, the purpose is to document how French students relate to their school science classes, with a data from a Relevance of Science Education (ROSE) questionnaire-based study involving 2395 students (1264 girls; 1131 boys). The findings of our research show some interesting gender differences and there is no sense to treat girls as though they were a homogeneous group.

Keywords

Gender, relationship to scientific knowledge, ROSE project, French student, secondary school science, science education

Résumé

Le rôle de la science et de la technologie est extrêmement important pour la société contemporaine ; alors que l'expertise en science et en technologie s'est révélée politiquement une question clé, les pays industrialisés ont observé une baisse de l'intérêt des élèves à étudier et à poursuivre des carrières dans des domaines scientifiques. Dans le présent article, le but est de documenter comment les élèves Français se rapportent à leurs classes de sciences, avec des données issues d'une étude basée sur l'enquête internationale ROSE et impliquant 2395 étudiants (1264 filles; 1131 garçons). Les résultats de notre recherche montrent des *différences intéressantes entre les sexes et suggèrent qu'il n'y a pas de raison de traiter les filles comme s'il s'agissait d'un groupe homogène.*

Mots-Clés
Genre, rapport aux savoirs scientifiques, projet ROSE, élève Français, science au secondaire, éducation scientifique

Students' experiences of school science and gender differences

The promotion of favourable attitudes towards science, scientists and learning science has always been a component of science education (Osborne, Simon, & Collons, 2003), and research in science education had/and will have a considerable contribution in this field. Some synthesis of Osborne et al. (2003) and Venturini (2004) have focused on students' attitudes towards science, while other studies have summarized the "student voice" (Jenkins, 2006). Other works have complemented this core of studies by redirecting research at exploring more directly on what students think about the science curriculum (e.g., Désautels, 2002; Murray & Reiss, 2005; Osborne & Collins, 2000, 2001). The rejection of science is attested (Boilevin, 2013; Boilevin & Ravanis, 2007; Whitfield, 1980 cited by Osborne et al., 2003); likewise the lack of significance in the contemporary curriculum is still on increase (Osborne et al., 2003; Sjøberg & Schreiner, 2010). PISA 2006 assert that in all countries, more than two-thirds of students stated that they considered science important and useful. However, only 21% of students say they make science a central issue in their lives; about 37% of them imagine themselves working in a career related to science (OECD, 2009). Consequently, it's important to emphasise the differences in students' attitudes towards the different scientific disciplines, since much of the research that has been undertaken to identify students' views about aspects of their school science education has been done in terms of 'science' rather than of individual scientific disciplines (Jenkins, 2006).

For some researchers, gender differences and gender stereotyping have been the focus of particular attention in national context (e.g., Blanchard, Orange, & Pierrel, 2016; Dutrévis & Toczek, 2007; Kalali, 2005, 2007a; Mariotti, 2002; UNESCO, 2017). More recent meta-analyses of a range of research studies had focus on gender in science (e.g., Brotman & Moore, 2008). It does appear, for example, that girls' antipathy towards science is their perception that they are better at other subjects (Jovanic & King, 1998) especially in reading literacy (Maciej & Borgonovi, 2012). The experience of school science erodes the interest of girls (Brotman & Moore, 2008; Kahle & Lakes, 1983). The gender differences show how important are learning styles among other factors. Staberg (1994) has established that boys have a practical while girls have a more theoretical approach to science. The motivation to learn science also seems to be dependent upon gender, type of science class and ability (DeBacker & Nelson, 2000).

Others studies highlight students' relationship to knowledge in francophone world (Charlot, 1997; Désautels, 2002; Kalali, 2007b; Kalali & Charlot, 2017; Kalali, Therriault, & Bader, 2019; Pouliot, Bader, & Therriault, 2010). The core of researches considers student as seen as a set of rapports[3] and process rather than position: he is singular with a psyche, but also an individual caught up in social relationships (Charlot, 1997, p. 50). Thus, the relationship to knowledge concerns three interrelated dimensions: the epistemic (refers to the learning process and objects of knowledge transmitted at school and generally enshrined in curricula and textbooks), the identity-related (refers to the individual's history, expectations, goals, values, views, relationships with others, self-perception), and the social (closely bound up with the identity-related dimension: interaction with others) (Kalali, 2007b; Pouliot et al., 2010).

Purpose and methodology

Consultation with pupils about their school science education is unusual in France, and where it has occurred, it has rarely led to radical reform. A consultation of high school students in 1998 (Meirieu, 1998) involved no fewer than 76% of the cohort but generated only minor change. Less than a decade after, a 'National debate on the future of the school' (Commission du débat national, 2004) had involve approximately 46% of teachers, 37% of parents and only 8% of young people. The resulting report (Thélot, 2004) and the curricula that are produced (Ministry of National Education in France, 2005, 2016) eschewed structural change in favour of gender equity and reforming content in terms of enabling students to build a consistent representation of the world in which they live. However, students' views cannot be the sole determinant of the science curriculum. The purpose of this study is to document students' views, priorities and aspirations towards their science classes in order to understand their relationship to school science (Désautels, 2002; Pouliot et al., 2010). We hope to collect and analyze empirical evidence that sheds light on the issue.

The research reported here is based on students' responses to the section of the questionnaire entitled "My science classes". The sixteen statements about "My science classes" are reported to different aspects, like motivation for science at school, self-confidence of students in their own abilities in science at school, their perceptions of science education, and what they get out of science at school (Schreiner & Sjøberg, 2004, p. 66). The present study addresses the following questions:

- How do students relate to their classes?

3 Lacan was the first to use relationship to/rapport to in order to reintroduce subject without naming it.

- Are there any significant gender differences in the students' responses?
- How do French students' views compare with those of students in other countries?

The results of section "My science classes" are crossed with some of the 108 items of sections about what they would like to "learn about".

A Likert scale was chosen with a 4-point Likert scale from "Disagree" to "Agree" 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 by Cohen, Manion and Morisson (2000), and by Aikenhead and Ryan (1992).

Our analytical procedures are based on measure of the mean and standard deviation (S.D.) of each item in sections. The middle point of the scale corresponds to 2.5. The means of boys and girls have been compared by using the Independent-samples T-test. In order to be *internally consistent and unidimensional* (Gardner, 1975), we had as commonly determined calculate for some groups of items, Cronbach's Alpha (α). The unidimensionality of items from the responses by gender are tested using an appropriate statistical technique, the Principal Component Analysis (PCA).

Sample

The target population concerned with ROSE is pupils aged 15. The sample on which this study is based was drawn 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 2395 students' responses (1264 girls, 1131 boys) were coded in our laboratory and analyzed by the researcher in accordance with the procedure laid down by the ROSE Project in Oslo. Data were analyzed with SPSS as recommended by the Norwegians of the project managers and sent to the University of Oslo.

Results

The students' responses to the sixteen statements of section "My science classes" are given in table 1. Gender differences in these responses, with an indication of their statistical significance are given in table 2.

Descriptive statistics and statistical significance

TABLE 1

French students' responses to statements about "science classes"

Statements	Disagree %	Low disa-gree* %	Low agree* %	Agree %	Nil Response %
1. School science is a difficult subject	28.6	24.9	20.1	25.1	1.0
2. School science is interesting	16.1	19.6	28.9	33.7	1.4
3. School science is rather easy for me to learn	26.1	25.5	26.2	19.8	2.0
4. School science has opened my eyes to new and exciting jobs	39.6	24.5	16.7	17.2	1.7
5. I like school science better than most other subjects	43.4	22.1	16.5	16.4	1.4
6. I think everybody should learn school science	17.1	19.2	23.6	38.3	1.5
7. The things that I learn in science at school will be helpful in my everyday life	18.4	22.9	26.7	29.6	2.0
8. I think that the science I learn at school will improve my career chances	30.2	24.8	21.8	21.3	1.7
9. School science has made me more critical and sceptical	37.5	28.1	18.6	12.9	2.8
10. School science has increase my curiosity about things we cannot yet explain	21.5	17.1	24.3	34.9	2.1
11. School science has increase my appreciation of nature	33.7	24.6	21.5	18.3	1.8
12. School science has shown me the importance of science for our way of living	25.9	23.9	26.0	21.9	2.1
13. School science has taught me how to take better care of my health	25.6	21.7	25.6	26.2	1.4
14. I would like to become a scientist	59.7	14.2	12.3	12.1	1.6
15. I would like to have as much science as possible at school	50.7	22.0	13.5	11.8	1.9
16. I would like to get a job in technology	55.0	18.2	12.4	11.9	2.3

*The identifiers low disagree and low agree do not appear on the ROSE questionnaire

The students' responses (table 1) suggest that few of them aspire to become scientists (59.7% students disagree with statement 14), to get a job in technology (55% of students disagree with statement 16), like school science better than other subjects (statement 5 with 43.4% of students who disagree) or like to have as much science as possible at school (statement 15 with 50.7% of students who disagree). School science is also regarded as not relevant about exciting jobs or about forming critical and skeptical mind (statements 4, 8, 9 and 11). In contrast, students find school science interesting (statement 2 with 33.7% of students agree and 16.1% disagree) and important for everybody (statement 6 with 38.3% of students agree and 17.1% disagree), or helpful to increase their curiosity about things not yet explain (statement 10 with 34.9% of students agree and 21.5% disagree).

TABLE 2

Girls and boys responses (mean score and S.D.) to statements about "science classes"

Statements	Girls Mean (S.D.)	Boys Mean (S.D.)	t	p
1. School science is a difficult subject	2.47 (1.142)	2.40 (1.235)	1.356	.175
2. School science is interesting	2.48 (1.062)	2.82 (1.161)	.307	.759
3. School science is rather easy for me to learn	2.32 (1.104)	2.55 (1.140)	-5.051	.000*
4. School science has opened my eyes to new and exciting jobs	2.15 (1.202)	2.12 (1.143)	.570	.569
5. I like school science better than most other subjects	1.97 (1.124)	2.18 (1.192)	-4.361	.000*
6. I think everybody should learn school science	2.91 (1.108)	2.82 (1.202)	1.888	.059
7. The things that I learn in science at school will be helpful in my everyday life	2.77 (1.091)	2.65 (1.179)	2.410	.016*
8. I think that the science I learn at school will improve my career chances	2.31 (1.144)	2.41 (1.154)	-1.927	.054
9. School science has made me more critical and sceptical	2.07 (1.048)	2.08 (1.094)	-0.69	.945
10. School science has increase my curiosity about things we cannot yet explain	2.76 (1.155)	2.74 (1.186)	.477	.633
11. School science has increase my appreciation of nature	2.22 (1.106)	2.30 (1.165)	-1.644	.100
12. School science has shown me the importance of science for our way of living	2.50 (1.108)	2.41 (1.141)	1.748	.081
13. School science has taught me how to take better care of my health	2.62 (1.144)	2.45 (1.143)	3.658	.000*
14. I would like to become a scientist	1.64 (1.029)	1.91 (1.161)	-6.032	.000*
15. I would like to have as much science as possible at school	1.74 (1.008)	2.02 (1.137)	-6.240	.000*
16. I would like to get a job in technology	1.51 (0.883)	2.15 (1.197)	-14.739	.000*

*Statistically significant, $p < 0.05$

Table 2 gives the gender differences in the mean scores with standard deviations for boys and girls. While girls and boys are disagree with statement 14 (to become a scientist), we have some salient gender differences. Girls were more disagree with statement 5 "I like school science better than most other subjects", statement 15 "I would like to have as much science as possible at school" and statement 16 "I would like to get a job in technology". These differences are statistically significant ($p < 0.05$).

Principal Component Analysis (PCA)

TABLE 3

Principal Components Analysis of the responses to the statements about science classes for (girls) and boys

	Component		
Statements	**1**	**2**	**3**
1. School science is a difficult subject	(.112), -.177	(.029), .757	(-.826)
2. School science is interesting	(.607), .724	(.293), .177	(.339)
3. School science is rather easy for me to learn	(.353), .767	(.311), -.044	(.521)
4. School science has opened my eyes to new and exciting jobs	(.500), .669	(.444), .380	(.036)
5. I like school science better than most other subjects	(.375), .825	(.650), .164	(.325)
6. I think everybody should learn school science	(.633), .719	(.196), .270	(.291)
7. The things that I learn in science at school will be helpful in my every-day life	(.650), .623	(.216), .332	(.169)
8. I think that the science I learn at school will improve my career chances	(.476), .689	(.497), .327	(.103)
9. School science has made me more critical and sceptical	(.551), .597	(.239), .472	(-.124)
10. School science has increase my curiosity about things we cannot yet explain	(.702), .590	(.184), .455	(.135)
11. School science has increase my appreciation of nature	(.694), .467	(.245), .613	(-.004)
12. School science has shown me the importance of science for our way of living	(.714), .546	(.220), .548	(-.033)
13. School science has taught me how to take better care of my health	(.682), .484	(.146), .594	(-.067)
14. I would like to become a scientist	(.162), .695	(.828), .300	(.114)
15. I would like to have as much science as possible at school	(.284), .744	(.776), .284	(.177)
16. I would like to get a job in technology	(.200), .455	(.681), .458	(-.171)

Rotation Method: Varimax with Kaiser Normalization.
The Analysis identified two main factors for boys and three for girls: the percentages of variance in the case of boys are 49.934% and 7.248%; for girls the corresponding percentages are 40.331%, 8.036% and 7.033%.

The two main components 1 and 2 are highly contrasted by gender differences. The first component in table 3 shows a contrasted group of girls and boys. It suggests that boys who want to be scientists, to get a job in technology or like school science (statements 5 and 15) also display a high degree of agreement with interest toward school science (statements 2), its importance (statements 6 and 12), its relevance (statements 4, 7, 8, 9, 10, 11, 12 and 13). In contrast, while girls find school science interesting, relevant and important, there is no corresponding association with a desire to be scientists (statement 14), to have a much science at school (statement 15) or to get a job in technology (statement 16). It is notable that 40% of all the variation in responses of girls is attributable to this component.

The second component presents another group of girls (8% of variance) who want to become scientists or to get a job in technology. These girls display a high degree of agreement with statement 5 "I like school science better than most other subjects" and statement 15 "I would like to have as much science as possible at school". They also find science school relevant for improving career chances and getting new jobs (statements 4 and 8).

The key message of our survey is that girls who aspire to become scientists are those who value science school itself as subject and show an intrinsic motivation (statements 5 and 15). We have sought to confirm this relation by the calculation of correlations with the Cronbach's alpha index for measuring the internal consistency of the items within a group. Thus, for the group formed by the proposal 14 (becoming scientific), proposals 5 & 15 (present and prospective motivation for science): the value of the coefficient ($\alpha = 0.803$) shows proposals to strong internal correlation ($0.7 < \alpha < 0.9$). The matrix of correlations shows that all proposals are correlated ($r > 0.4$).

The ROSE questionnaire also includes three sections with 108 statements in which students were invited to declare what they would like to "learn about". For the full list of statements, the reader is referred to details of the questionnaire (Schreiner & Sjøberg, 2004). The comparison of the means scores of the two groups formed by girls and boys with the T-test revealed that of 108 items, 91 generated responses from boys and girls that were statistically different (Kalali, 2010).

TABLE 4

The most popular items for girls (mean score is ≥ 3) and their corresponding values for boys

Statements	Mean girls	S.D. girls	Mean boys	S.D. boys
C13. Why we dream while we are sleeping, and what the dreams may means	3.51	.859	3.09	1.089
E10. How to perform first-aid and use basic medical equipment	3.38	.913	3.04	1.066
E8. Cancer, what we know and how can treat it	3.38	.880	2.91	1.103
E11. What we know about HIV/AIDS and how to control it	3.31	.953	2.94	1.071
E9. Sexually transmitted diseases and how to be protect against them	3.29	.961	2.97	1.073
E12. How alcohol and tobacco might affect the body	3.20	.987	2.80	1.115
C11. Life and death and the human soul	3.20	1.037	2.90	1.184
E13. How different narcotics might affect the body	3.19	1.004	2.83	1.124
E7. How to control epidemics and diseases	3.19	.946	2.76	1.123
A11. How babies grow and mature	3.12	.979	2.45	1.058
A40. How to exercise to keep the body fit and strong	3.12	1.058	2.67	1.153
A38. Eating disorders like anorexia and bulimia	3.11	1.053	2.04	1.087

TABLE 4

A39. The ability of lotions and creams to keep the skin young	3.07	1.113	1.94	1.119
C15. Thought transference, mind-reading, sixth sense, intuition, etc.	3.05	1.101	2.74	1.209
A10. Birth control and contraception	3.04	1.021	2.44	1.051
E23. How my body grows and matures	3.03	1.054	2.77	1.100
A7. How the human body is built and functions	3.02	1.015	2.70	1.086

TABLE 5

The most popular items for boys (mean score is ≥ 3) and their corresponding values for girls

Statements	Mean boys	S.D. boys	Mean girls	S.D. girls
A30. How the atom bomb functions	3.28	1.027	2.50	1.181
A31. Explosive chemicals	3.19	1.034	2.40	1.161
C7. How computers work	3.17	1.017	2.72	1.101
A34. How it feel to be weightless in space	3.15	1.093	2.90	1.167
E42. Phenomena that scientists still cannot explain	3.10	1.137	2.87	1.204
C13. Why we dream while we are sleeping, and what the dreams may means	3.09	1.090	3.52	.853
A9. Sex and reproduction	3.07	1.035	2.91	1.040
A22. Black holes, supernovas and others spectacular objects in outer space	3.04	1.139	2.54	1.209
E10. How to perform first-aid and use basic medical equipment	3.04	1.081	3.39	.902
E40. Inventions and discoveries that have changed the world	3.01	1.086	2.74	1.146
A23. How meteors, comets or asteroids may cause disasters on earth	3.01	1.098	2.56	1.142

TABLE 6

The less popular items for boys and girls (mean score is≤ 2)

Statements	Mean boys	S.D. boys	Mean girls	S.D. girls
A15. How plants grow and reproduce	1.87	.988	1.86	.996
E1. Symmetries and patterns in lives and flowers	1.47	.897	1.58	.903
E17. How to improve the harvest in gardens and farms	1.91	1.046	1.80	.966
E19. Organic and ecological farming without use of pesticides and artificial fertilizers	1.99	1.069	1.93	1.109
E25. Plants in my area	1.93	1.014	1.90	.987
E33. Benefits and possible hazards of modern methods of farming	1.95	1.073	1.75	.996
E37. Famous scientists and their lives	1.95	1.099	1.72	1.026

The most interesting items for girls and for boys (mean score is ≥ 3) are given respectively in tables 4 and 5. The less popular items for boys and girls are given in table 6. About the less popular items with the mean score ≤ 2 (table 6), boys and girls have the same rejection about botanic and methods of farming (organic, modern, or ecological). It seems that we have a consensus for the less popular items. For the most popular subjects (tables 4 and 5), girls and boys show some specific priorities. The most popular items for girls (table 4) are those relating to human biology, health, well-being, mystery. For boys, the most popular items are different and relate to universe, technology, atom bomb (table 5). However, it's important to declare that a high level of interest in a given item by one gender does not mean that the same item is of no interest to the other. For example, whereas "Sexually transmitted diseases and how to protect against them" is a topic which most girls indicate strongly they would wish to lean about (mean score 3.29), the topic is also of interest to boys with a score mean equal to 2.97. Similarly, boys would wish to learn about "What we know about HIV/AIDS and how to control it" (mean score 2.94), and about "How different narcotics might affect the body" (mean score 2.83). It's notable that these items imply the teen identity and would be of interest to boys. In contrast, boys are less interested in learning about public health "How to control epidemics and diseases" (mean 2.76). Likewise, they feel not interested in learning about "Eating disorders like anorexia and bulimia" (mean score 2.04). The gender difference lies with some priorities of girls and boys. Girls (table 5) feel interested like boys in learning about "How it feels to be weightless in space" (mean score 2.90), and about "Sex and reproduction" (mean score 2.91). However, they are less interested in learning about "How meteors, comets or asteroids my cause disasters on earth" (mean score 2.56), about "Explosive chemicals" (mean score 2.40), and neutral about learning "How the atom bomb functions" (mean score 2.50[4]), that are boys' priorities.

TABLE 7

Principal components analysis of the girls' responses to the sections A/C/E

Component 1	Component 1 (cont.)	Component 2
How meteors, comets or asteroids may cause disasters on earth (0,514)	How energy can be saved or used in a more effective way (0,535)	Sex and reproduction (0,524)
How X-rays, ultrasound, etc. are used in medicine (0,510)	New sources of energy from the sun, wind, tides, waves, etc. (0,560)	Birth control and contraception (0,544)
How crude oil is converted to other materials, like plastics and textiles (0,520)	Plants in my area (0,519)	Eating disorders like anorexia and bulimia (0,523)

4 By assigning a score from 1 (Disagree) to 4 (Agree) to the students' answers, it is possible to regard a mean score of 2.5 as representing a neutral position.

TABLE 7

Optical instruments and how they work (0,508)	Electricity, how it is produced and used in the home (0,542)	The ability of lotions and creams to keep the skin young (0,530)
How cassette tapes, CDs and DVDs store and play (0,490)	The first landing on the moon and the history of space exploration (0,558)	How to exercise to keep the body fit and strong (0,527)
Why the stars twinkle and the sky is blue (0,509)	How electricity has affected the development of our society (0,569)	Sexually transmitted diseases and how to be protect against them (0,541)
Why we can see the rainbow (0,509)	Benefits and possible hazards of modern methods of farming (0,494)	
How the sunset colours the sky (0,491)	Why scientists sometimes disagree (0,526)	
The greenhouse effect and how it may be changed by humans (0,555)	Big blunders and mistakes in research and inventions (0,529)	
What can be done to ensure clear air and safe drinking water (0,506)	How scientific ideas sometimes challenge religion, authority and tradition (0,523)	
How technology helps us to handle waste, garbage and sewage (0,524)	Inventions and discoveries that have changed the world (0,571)	
How to control epidemics and diseases (0,501)	Very recent inventions and discoveries in science and technology (0,566)	
How loud sound and noise may damage my hearing (0,554)	Phenomena that scientists still cannot explain (0,552)	
Medicinal use of plants (0,510)		

Extraction Method: principal component Analysis. Rotation Method: Varimax with Kaiser Normalization.

TABLE 8

Principal components analysis of the boys' responses to the sections A/C/E

Component 1	**Component 2**	**Component 3**
Animals in my area (0,528)	How to control epidemics and diseases (0,629)	Optical instruments and how they work (0, 624)
Plants in my area (0,628)	Cancer, what we know and how we can treat it (0,653)	The use of lasers for technical purposes **(0,721)**
Detergents, soaps and how they work (0,612)	Sexually transmitted diseases and how to be protect against them (0,662)	How cassette tapes, CDs and DVDs store and play (0,754)

TABLE 8

Electricity, how it is produced and used in the home (0,566)	How to perform first-aid and use basic medical equipment (0,579)	How things like radios and televisions work **(0,751)**
How to use and repair everyday electrical and mechanical equipment (0,529)	What we know about HIV/AIDS and how to control it **(0,706)**	How mobiles phones can send and receive messages **(0,709)**
The first landing on the moon and the history of space exploration (0,588)	How alcohol and tobacco might affect the body (0,661)	How computers work (0,682)
How electricity has affected the development of our society (0,653)	How different narcotics might affect the body (0,654)	
Biological and human aspects of abortion (0,654)	How loud sound and noise may damage my hearing (0,502)	
How gene technology can prevent diseases (0,630)		
Benefits and possible hazards of modern methods of farming (0,672)		
Why religion and science sometimes are in conflict (0,680)		
Risks and benefits of food additives (0,619)		
Why scientists sometimes disagree **(0,737)**		
Famous scientists and their life **(0,732)**		
Big blunders and mistakes in research and inventions (0,698)		
How scientific ideas sometimes challenge religion, authority and tradition **(0,720)**		
Inventions and discoveries that have changed the world (0,649)		
Very recent inventions and discoveries in science and technology (0,639)		
Phenomena that scientists still cannot explain (0,613)		

Extraction Method: principal component Analysis. Rotation Method: Varimax with Kaiser Normalization.

Factor analysis of the responses to sections A, C and E by gender helps to clarify the picture. Two factors are identifiable in the case of girls accounting for 19% and 5% of the total variance respectively (table 7). The first component covers several items in relation with science and its impact on society, life and health; other items are related to the environment, energy, universe... The second factor shows the items that refer to the concerns of girls as well related to the protection against the sexually transmitted diseases, reproduction, eating disorders, and lotions and fitness benefits.

In the case of boys, factor analysis shows three components accounting for 23%, 6% and 3.54% of the total variance respectively (table 8). The first factor shows items related to science, the impact of technology or industry on society, the local environment and everyday life. The second factor shows the items that refer to the concerns of boys in relation to health (disease, drugs, alcohol...). Girls, show similar group but with a few items in relation with disease; it is enriched in addition of items dealing with the effect of lotions and fitness, about eating disorders. The third factor (only for boys) includes items that refer to the technology and instruments.

Discussion

The French students' responses suggest that school science failed to be relevant for many ways, especially for improving career chances. In accordance with Sjøberg and Schreiner (2010, 2011), we recognize that the mechanisms underlying young people's priorities are multifaceted and difficult to understand.

Despite the differences that may exist between the various national educational systems of the countries involved in the ROSE project, these common trends underlie some common factors. Désautels (2002) consider that school science underlies by all institutional, curricular and pedagogical practices leads to produce for a large number of students some forms, more or less dogmatic, more or less inhibiting, of relationship to scientific knowledge that contribute to the (re)production of the social hierarchy of knowledge (pp. 88-89). The French students find school science "interesting", but unable to lead to "think critically" or to "appreciate nature". As Désautels has noted, probably in this context, school science fails to attract. French students agree noticeably with the statement "I think everybody should learn school science", but they disagree strongly with statements: "I like school science better than most other subjects" and "I would like to have as much science as possible at school". Reporting again on the others countries, Sjøberg and Schreiner (2010) have found a marked contrast with developing countries. The rejection of science and the lack of significance of curriculum attested by Osborne et al. (2003) still find an echo in ROSE studies. Jenkins and Nelson (2005) describe this situation for students from England as "It's important but not for me". It would be surprising if French students did not share this view, but what follows would be needed to establish whether this is indeed the case.

Although ROSE project does not specify what science is underlying, the radical students' response to the proposition related to get a job in science area is enough to highlight students' repulsion. Our study shows some interesting gendered results. They suggest that boys who want to be scientists display also a high degree of agreement with interest toward school science, its importance, and its relevance (component 1, table 3). In contrast, major group of girls find school science interesting, relevant and important, but don't want "to become a scientist" or "to have as much science as possible at school"; similarly they don't "like school science better than most other subjects". These girls find *school science important but not for them*. It makes little sense to treat girls as though they were a homogeneous group (Blanchard et al., 2016; Brickhouse, Lowery, & Schultz, 2000). Indeed, a minor group of girls expressed a strong wish to become scientists or to have a job in technology (component 2, table 3). These girls are very different of their peers of girls. They expressed strongly their intrinsic motivation for science school (statements 5 and 15). In our study, the intrinsic motivation in school science has been found to be closely associated with a career aspiration in science for those girls that expressed this choice (attested by Cronbach's Alpha and PCA). For these girls engaging in science careers is related to an intrinsic motivation in science, to its theoretical and epistemological frame, and also perhaps to the Scientist who embodies it. As Martineau has declared (2002), these girls show an individualistic view of science practice that makes them demanding. Blanchard et al. (2016) state that girls who choose science as career are more sensitive to the intrinsic hierarchy of scientific knowledge rather than extrinsic hierarchy, that leads to some higher social position related to the careers. In accordance with authors, this relationship to scientific knowledge is rather perceived than transmitted by teachers. It works as a hidden curriculum. For some authors (Nozaki & Apple, 2002), the implementation of a curriculum systematically leads to the construction of a hidden curriculum, insofar as the curriculum is always a selection of knowledge selected by interest groups in position of power in society. We need for following research some data relating to the classroom environment, and explore contributing factors such as teachers' beliefs.

Let's examine what the students declare that they wished "to learn about". Although the number of such statements is large (108), there is no direct relationship with some pieces of science curriculum. It's interesting to find that items which are the girls' priorities and related to the health, human biology are also interesting for boys. Our results are consistent with other ROSE studies in different countries (ex. Jenkins & Nelson, 2005; Jidesjö et al., 2009; Sjøberg & Schreiner, 2010). Thus, we cannot declare that the girls report more interest than boys in human biology and health. It is important to keep in mind that both genders reported being interested in these topics, even if the means for girls are slightly higher. Given that gender differences are less marked for students aged 15, we can't take stereotypes as explanation for these items about health, human biology, and body. However, another interpretation on these data is possible. We can observe that all of the items that are priorities for girls form a mosaic (foundation) in terms of health that takes into account of some dimension like body and also diseases in its social and scientific dimensions, and the well-being. It seems clear that some pieces are formed by the early years of secondary school and are to undergo developments differently before a final foundation. In the case of girls fifteen old aged, these interests about health, body and diseases are stable. Some interests of boys seem to evolve with age and to fall into line with those of girls (e.g., human body, its biological and physiological function...) or move away (e.g., diseases) (Kalali, 2010). The French responsible of curriculum present these topics under the component of "Education for Health": these themes have been identified earlier as relevant for students in this age group.

We have identified that "school science" and "science at school" mean in the ROSE questionnaire: biology, geology, physics, chemistry, geophysics, astronomy (Schreiner & Sjøberg, 2004, p. 67). Which of these sciences is in the mind of students who are responding to our questions? It is probably all these matters. What is certain is that school science seems engaging when there is a bond with students' concerns as health and disease related to body. These themes that suggest immediate applications are not questionable for students. Since then, the emergence of ethical issues makes problematic today which was so far not questionable (Roth & Désautels, 2002). The items that are the boys' priorities related to universe or explosive bomb are also interesting for girls, except "black holes…", "meteors…" and "atom bomb" (Means are near neutral position). In France, we can find these themes in scientific magazines rather in school science curriculum. It seems that we have here some opportunity to attract girls to some out-of- school experiences in according with researchers (e.g., Breakwell & Robertson, 2001). Similarly with biology above, we have the same reserve. Once again, we can't take stereotypes as explanation for some items like universe. Once again, we observe that items that are priorities for one sex are also interesting for the other sex. Girls' priorities do not come under the *female universe* as we can read in literature. By asserting this, it indicates that we think women in their substantial form. Whether in terms of their motivation to learn school science, of their perceptions of science education, of what they get out of science at school and technology, there are significant differences on the views of most boys and girls. We are conscious of the limits of our research, in particular the quantitative tool that does not allow access to data as students' discourses about their learning. However, we can find some aspects of "Relationship to knowledge" as we saw above in the discussion. Students build this "report" on aspects like motivation, self-confidence, views, and values in interaction with their school, cultural, social environment and also during their individual history. While it is important to consider also how this is related to who they think they are (Brickhouse et al., 2000), these differences raise the question of whether a common science curriculum and pedagogy can be best to meet the hopes of both boys and girls.

Conclusions

The rejection of science and the lack of significance of curriculum attested by Osborne et al. (2003) still find an echo in ROSE studies. This problem is multidimensional (political, cultural, scientific and societal). These various dimensions must be treated together. The point is to promote personal relevance and integrate scientific knowledge into complex practical solutions without make obsolete the development of students understanding of the social and institutional basis of scientific credibility; and as revealed by studies such as ROSE enable students to build on their own enduring, science-related interests.

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