

„Open gates, closed gates – mathematics and sciences in secondary education in France“

Abstract

Since 1994-1995, general secondary education curriculum in France proposes three choices; L, ES and S, to pupils, at the end of their first secondary school year (15 years old). Those three choices have clear boundaries, and are strongly linked to social representations concerning the French job market's opportunities. This paper will show how peculiarly in France's situation, mathematics and sciences are becoming gates, which give or refuse to pupils a wider possibility concerning job opportunity. We will base ourselves, to introduce the paper, on quantitative data to present the disharmonized situation between L, ES and S curricula, and then, basing ourselves on the first results of MOTIVATION project: <http://www.motivation-project.com> concerning France, we will reflect and thus analyse this situation using qualitative data.

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Introduction.

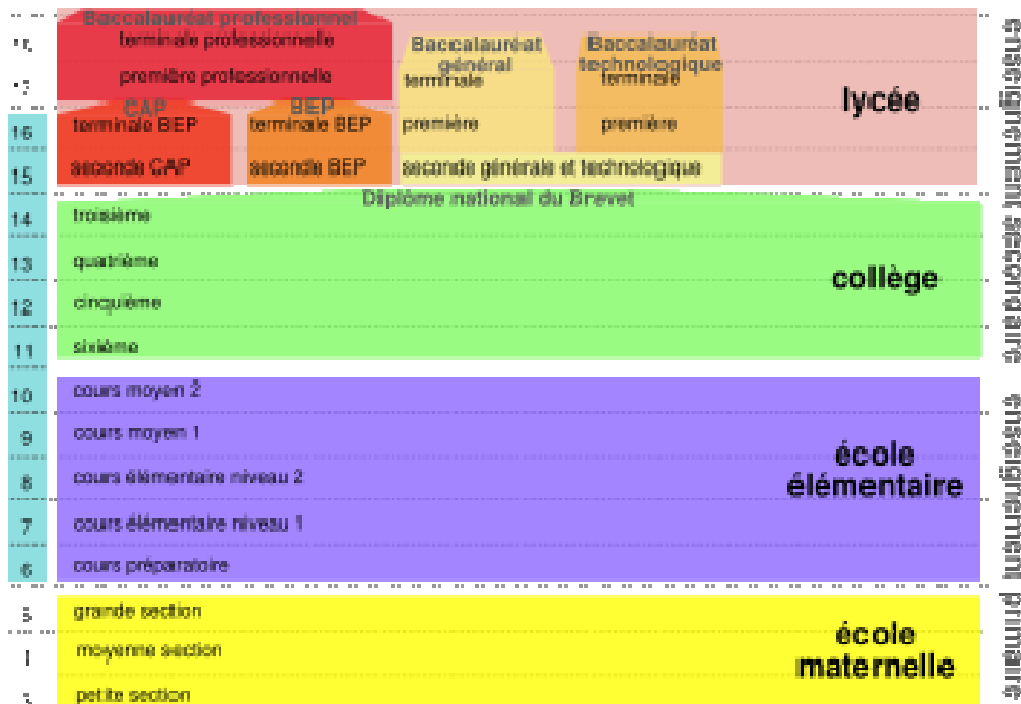
Science and SET, studies, jobs and careers have always been men's fields and masculine "Bastions". Male and female teenagers, confronted to choices during their scholar curriculum, observe and share gendered attitudes and opinions, influencing them on important choices concerning their future.

If boys are the heirs of this scientific tradition, girls are more implicated when they choose those peculiar paths, disciplines and jobs (Mariotti, 2002). Concerning boys, choosing a scientific education is more "automatic": it is the result of a normative societal pressure. Girls, choosing a scientific education, feel more valorised, as to attract girls in scientific fields is given large media coverage! But those high prestige jobs remain masculine, concentrating men in those peculiar fields. Stevanovic (Stevanovic, 2006) analyses the relevance and impact of gender representations concerning choosing scientific education, training and jobs: Lack of self-confidence, uncertainty growing with ageing, anticipation of traditional roles concerning private sphere, masculine image and strong representations deter girls from choosing scientific paths. The feminine-said gender identity does not match with those technical and scientific job representations. Gender representations still influence boys and girls' choices: Mariotti (Mariotti, 2002) assesses that the only legitimate sex to study and makes career in science remains and is the male one.

1. The French scholar system

The French scholar system actually presents four main sections: “école maternelle”, école élémentaire”, “collège” and “lycée”.

Overview of the French scholar system:



<http://www.inca.org.uk/france-curricula-mainstream.html>

International Review of Curriculum and Assessment Frameworks Internet Archive (20/11/2008)

Depending their orientation choices, French male and female pupils can have very different scholar ways regarding several orientation steps choices during scholar period. We will focus on one of these steps; before attending general section in second and final year of secondary high school (age is around 16). In 2005-2006, 95% of the girls and 91% of the boys have reached the V level¹ in France, using different ways. 68% of the girls, and 57% of the boys (2005) have their final high school exam. After the first year of secondary high school, (Classe de Seconde) pupils have three choices: general, professional or technological section.

¹ V level is accessing first year of secondary high school or final training year before CAP; Certificate of professional competencies, BEP; Diploma of Professional studies, or an equivalent diploma.

27,3 of the boys, and 40,3% of the girls passed their final high school exam in the general section. 16,3% of the boys, and 18,3% of the girls passed their final high school exam in the technological section, and 13,2% of the boys, 9,8% of the girls passed their final high school exam in the professional section. (Final high school exam, session 2005-2006, MEN-DEPP). Considering the general section path, the pupils have here the possibility to choose between L, ES and S ². L is for Literature, its main discipline³ is philosophy (final year of secondary high school), then literature, and languages. ES means Economy and Society, and privileges this discipline, at the same rank as languages, history and geography, and scientific disciplines. S is for sciences: its main disciplines are the scientific ones (Mathematics, Physics, Biology, and Chemistry).

A. General statistics

From primary to secondary high school

Considering orientation choices, French pupils, at the end of primary high school, obtaining identical marks, wish the same: 68% of the boys and 75% of the girls wish to attend a general or technological section in secondary high school. 26% of the boys, and 21% of the girls would attend a BEP, (Diploma of professional studies; *Brevet d'études professionnelles*, a French high school diploma commonly abbreviated "BEP") 4% of the boys, 3 % of the girls will attend a CAP (Certificat of professional competencies, a French high school diploma preparing to have a job in a precise fieldwork) (pupils having attending first year of primary high school in 1995, MEN-DEPP). The differences of orientation are explained by the better results of the girls concerning Brevet, the final primary school exam.

The general section: L, ES and S

Gender has a deeper impact considering choices, and future possibilities of careers, studies and jobs, as choosing between L, ES and S widen or restrict your future opportunities. Girls would choose more L and ES than S or STI (Sciences, Engineering and technology) than boys.

In 2005, concerning pupils attending second year, (Classe de Première) choosing general and technological sections at Secondary High School; 41% of the boys attended S, 6% attended L, 14% attended ES, 13% attended Industrial Sciences and Technologies, 13% attended

² These terminology and curricula appeared through the Secondary High School's 1992 reform: Classe de Seconde was reformed in 1992, Classe de Première in 1993, and finally Classe de Terminale in 1994.

³ E.g. highest coefficient for final Secondary High School exam.

management sciences and technologies. In 2006, 29% of the girls attended S, 17% attended L, 23% attended ES, 1% attended Industrial Sciences and Technologies, 17% attended Management Sciences and Technologies (MEN- DEPP).

Considering the three main sections in the general path; L is composed by 80% of girls, ES at 62% and S at 45% of girls (2005, MEN- DEPP). We can notice thus no real parity in the general sections or considering the choice of options. Gender has a real impact on their choices: when they think they're very good in literature and French, 1 on 10 would choose L, while, being in the same case, 3 on 10 girls would choose L section. Considering S, when they think they're good in maths, 8 boys on 10 would attend S, while, being in the same case, 6 girls on 10 would attend S (MEN-DEPP; pupils having attending first year of primary high school in 1995).

Options (non compulsory disciplines) are gendered as well

Female and male pupils, having been choosing between L, ES and S, have to decide between optional disciplines for final secondary high school exam. Their choices are gendered as well: considering peculiarly S, around 20% of the boys would choose engineering sciences, while 5 % of the girls would have the same choice.

Furthermore, girls choose more “general” options than “technological” ones. In 2005, in first year of secondary high school, general and technological ones, only 3,6% of the girls chose as an option “initiation of engineering sciences” while 13,7% of the boys attended it. At the contrary, 8,5% of the girls choose third language as an option, while 3,5% of the boys chose it. 0,5% of the girls, and 8,9% of the boys chose computer science and industrial system without or with an initiation to engineering sciences. (2005, MEN-DEPP). 94% of girls attending SMS (medico-social sciences) as an option, while boys chose in a majority computer science option (94%) (2005, MEN-DEPP).

B. Evolution and attractiveness of L, Es and S, and options' choices from 1997 to 2007

Since 1997, S gathered plus 17,6% more female, and plus 1,58% more males. ES attracted plus 20,6% females, and plus 7,6% males. L lost minus 32,4% females and minus 18,1% males (MEN-DEPP 2006). L lost nearly one third of its female effective on 10 years, and nearly one fifth of its male effective. ES is the big last tenth years winner, attracting nearly one fourth of the female, and less than one tenth of the male. S attracted less than one fifth

female effective, and a very few more boys. S stays over invested by male, ES attracted the highest female effective, and L lost the highest female effective during those last ten years. To explain those results, the L attractiveness dramatically decreased because of its said non-future opportunities considering job and career. S is called the king's way, as it is said to open all possibilities and studies opportunities. ES is the second choice. ES and L gather now all pupils who could not attend S, a few of interested pupils, and so called "bad pupils" or very hesitant ones. S became, and scientific disciplines, especially Mathematics, the excellence section, and sciences are now opening, or closing gates to pupils. Mathematics has become the selectivity's queen discipline, within the others scientific disciplines: it is now a tool to divide good from bad pupils, and has a very important impact on pupils' future opportunities and possibilities.

If we focus precisely on S section and its options (Biology, Maths, Physics Chemistry) we shall understand this phenomenon better. Maths, as an option, from 1997 to 2007, has lost minus 14% of its female effective, minus 11% of its male effective. Physics Chemistry won plus 12% of its female effective, and plus 10% of its male effective. Biology: plus 2% of its female effective in ten years, plus 1% of its male effective from 1997 to 2007 (MEN-DEPP, 2006). Maths is thus even rejected by either male or female S pupils, those who would be expected to "like" it, being sciences lovers! Biology kept constant attractiveness, and physics chemistry attracted the former Maths lovers.

Girls and boys

Girls would more easily choose general trainings, while boys select more professional trainings: they incorporate masculine or feminine said culture, as peer group influence is increasing through ages. Duru-Bellat (Duru-Bellat, 2004) analyses the auto censorship phenomenon concerning girls, refusing to challenge boys on their masculine territory. They nevertheless choose scientific trainings if they're very good, while boys would choose these trainings even if they're average students, as they are supported by teachers and parents, and expected to. Representations concerning scientific disciplines are still strong, and are closely associated with masculinity, rejecting girls from them. Peculiarly, mathematics is considered as a masculine dominion, which is though deterring girls from it. Fontanini (Fontanini, 2006) analyses the lack of self-confidence of girls regarding mathematics as being a gender effect bias. Nicole Mosconi (Mosconi, 1994) analyses the relationship between future professional work and boys and girls: For girls, it is not evident, for boys, it is contingent: orientation choices are the result of a whole social system based on women' subordination to professional

and family spheres. Girls and boys confront through hidden curricula while choosing orientation. Analyses from the R.O.S.E research (ROSE project: The Relevance Of Science Education, <http://www.ils.uio.no/english/rose>) states that compared to less-economically developed countries, students from more economically developed countries showed less interest in science subjects. A possible explanation may be the disastrous image of the impact of SET on society (Chernobyl accident, mad cow and birds diseases, OGM...). Values, which are acknowledged in economically developed countries, cannot be found in SET images and representations. The more students are advancing in age, the more science do takes a negative image, associated with a “difficulty to learn” strong representation.

C. Maths and science as a (gender) brake

How did maths become a brake, and only (unfortunately) a brake? Maths, as a scientific discipline, does not attract anymore, either female or male pupils in S section. Maths was previously associated to progress, scientific progress, objectivity and neutrality. It has been considered as one of the less “discriminatory” discipline; all pupils could learn it, but excellent pupils would succeed solving and learning how to problematize successfully. Maths, if it’s a so said objective science, is highly gendered. It is associated to masculinity, and acted as a repellent to female pupils: the rates of French women researchers in maths and physics fields in industrial or higher education research institutions are very low. 17,9 % (Industrial), 21% (Maths in Higher Education) and 20% (Physics in Higher Education) of the researchers working in those fields are women. Comparing to Biology (46% of women in Industrial fields, 41,6% of women in Higher Education) and to Chemistry (32,2% of women in Industrial field, 26,3% in the Higher Education field) which attract more women; mathematics is an active women-repelling tool, as it is considered as being *the excellence* of the excellence way in France, and makes part of the old masculine fields “bastion” (Livre blanc, les femmes dans la recherche privée en France, 2004).

2. Qualitative data from MOTIVATION French fieldwork

The first round of MOTIVATION fieldwork have been organised between October and December 2008. Regarding the guidelines elaborated by the whole MOTIVATION team, we chose two “case studies”, two Secondary High Schools, one governed by the French state, the other being privatised⁴. We thus interviewed 10 pupils, male and females, from 15 to 17, and 5 teachers, teaching scientific disciplines or not. Our main objective was to investigate about their representations of Sciences, Engineering and Technology.

A. A certain family tradition

Pupils would follow a certain family tradition: our S pupils have parents in the scientific fields: FM11 (S) Mother is a dentist surgeon/Father is an ophthalmologist, both are doctors. *My parents imagine me attending scientific studies. I would prefer attend business studies.* FF21 (S) Mother is a biology researcher/Father is working in an agro alimentary firm. FM21 (S) Father works at the CEA (huge governmental research institute/ Mother is a housewife. Brother computer scientist. Sister looking for a job in biology at university.

Pupils who attend ES have more the “business” family type; parents are though working in firms, communication, marketing fields...FF22 (ES) Mother is in business, Dad is an accountant. FF13 (ES) Father is a firm manager, mother is a housewife. FM12 (ES) Two parents are writers; mother a writer, poet, and translator. FM22 (ES) Mother a bank executive/ Father a teacher in primary school.

L pupils are attending as well a discipline that is traditionally favoured in their family. FF11 (L) father is in the marketing/mother in the communication field: *I wasn't really into science, but at the same time, my family is not a scientific one, we are more into business/marketing, entrepreneurship.* FF12 (L) Parents are journalists. FF23 (L) Father was an architect. Mother is a French teacher at secondary high school.

B. Images of Sciences.

We find here the classic opposition Concrete Vs theoretical within pupils' discourse. Even S pupils would use this dichotomy arguing for example than maths is no daily use, and though

⁴ E.g. In France, in 2002, 14% of the first degree pupils and 20% of the second degree pupils were in the private scholar system, which means that you have to pay fees to attend such schools and high schools) (2002, MEN-DEPP).

does not bring huge interest. Biology would be more connected to reality, and be useful. L and ES pupil's discourses are, as expected, more negative towards science in general, but biology has kept a really good image.

FF11 (L) *Atoms...stuff...I need concrete, practical...I was bothered to study things that would never be useful in my life... I'm not somebody who has any logical sense, and mathematics is really a problem for me...it's really in the beautiful sentences and language... than in... the concrete Vs persons, atoms...*

FF13 (ES) *I prefer Maths this year, even if it's not really a good teacher, because it's really applied to economy. I don't like maths when it's theoretical... When it's no use...*

FF23 (L) *I choose L for the general knowledge, and self expressing, it's further more important that knowing to pose and solve an equation. In scientific disciplines? I've no interest for maths. Concerning alimentation, it was really interesting, it's everyday life! Worst job: in front of a screen: not really « sociable ».*

FF12 (L) *Scientific disciplines really seem to me disconnected from realities, micro problems that didn't bring anything interesting to me.*

FF22 (ES) *This year we keep biology, we have an exam at the end of the year, interesting subjects as neurology, procreation. It's everyday life.*

FM21 (S) *When we do something concrete, it really interests me. When it's really pure theory, like sometimes in maths, I don't like it at all.*

This definition even rubs on off scientific jobs, and scientists.

FF11 (L) *these are two different types of curiosity, even personality! (Less chatty/computer oriented).*

FM11 (S) *I like physics, but as I have friends, people don't call me a creep. I love it, but I don't exaggerate! You use maths as a support tool (opening doors).*

FM12 (ES) *There is of course the scientist image of someone who is not open, closed in his office, his universe, and equation, out of reality! (These are key jobs)*

Scientists are geeks, whose only passion are and will be sciences. He or she is out of reality. Passion is often associated with sciences, as if a definition of a scientist would often be: a passionate and though off reality.

FF11 (L) *we need it for the future but unfortunately I'm not gifted for sciences, I can't even count! So I leave it to the one whose passion is science!*

FM11 (S) *A friend, future researcher. A passionate, lover of sciences. I would not spend holidays to work. Not earning money.*

FF13 (ES) *People who are fond of science? He/she will be a geek! The cliché with the guy with glasses.*

FF23 (L) *in an office (worst job) linked to computer, in front of a screen. It's not really « sociable ».*

C. “Dry” disciplines

Those disciplines are “dry” disciplines, and taught as if they were not “alive”. Pupils would consider them as being not interesting; they do not make them “dream”!

FM12 (ES) *Alive disciplines, to create interest! Like Einstein relativity, who could make people dream... physics that would make people dream! The problem of scientific disciplines is that they're not taught as living disciplines.* FM11 (S) *My physics teacher is very ambitious, and thanks to her, we can go further than our classes, to understand the mechanism, not only to apply stupidly formulas. It changes everything!* FF22 (ES) *talking about her biology teacher: The teacher really gave me the will to learn this year, she gives us examples, we watch videos, asks for questions: it's really reactive!*

Those disciplines are known to demand harsh work, a huge workload, and an intensive learning by heart.

FF11 (L) *There were million of things to learn by heart (Physics)... In daily life, it has no interest ... S, you work a lot, you have a lot of homework, you get sad on Saturday night, you do maths, maths and maths.* FM11 (S) *I prefer physics to Maths, it interests me more than maths, as it is more concrete, but I don't think I will attend scientific studies after graduation. Maths is not a hobby!* FM11 (S) *Talking about physics and science preparatory classes: I like physics, but maybe it would be too much in preparatory class (higher level/stress/workload). I don't know if I could handle this huge workload and the stress as well. Physics will be less concrete, more theoretical; maybe I will not be as interested as I am? I would prefer to work as a liberal, and to keep a high level of living. I do not like hierarchy.*

When working for a science exam, pupils even work as “robots”. FF23 (L) *I hate physics. I always liked experiences, but since there are calculations, I don't need this for the future!! Physics is when you stuff your brain. I prepare exam like a robot, I will be relieved from it after this.*

Teachers relay these images as well, as they're talking with pupils: FMT21 (Biology teacher) classifies scientific disciplines in “dry” disciplines considering pupils' point of view: Maths is for real intellectuals, Chemistry is smoking firms, and Physics is Chernobyl. Biology is associated to a very positive image: it concerns the human being, and pupils just want to study the human being, and how does the body works and functions.

FMT1 (maths teacher) about the image of physics: *I often hear pupils complaining about physics. "Huge workload/very demanding. A lot of pupils would choose ES, to escape from physics."*

Those same teachers would as well teach in a very demanding and severe way: FMT1 (Maths) even if he is conscious of the dry aspect of its discipline (he uses computers to make pupils react and be interested) claims: *The good student: the one who follow the instructions! I succeed when pupils memorize instructions. Pupils interested to the proof: intellectual thought process.*

Some teachers as FMNT1 (Philosophy teacher) tries to wider the definition of science: *I use SET, to show that scientific is not only used by what we called « hard » sciences. (Epistemology).*

FFT21 (Biology teacher) was always interested by SET disciplines: *With L pupils, they're not so scientific, you may find another approach. You have to link it with actuality. It's far more complicated than S...Lessons are really interactive now (Power Point tools/videos...). I can see fewer engineers' projects in S (medicine/ business/economy); they want to have a real well remunerated job. They're very demanding. She feels sciences are really attractive to pupils. But they have no interests for the discipline but only for its job opportunities.*

D. Maths and the job opportunities problematic.

Unfortunately for Maths French teachers, Maths is not anymore appearing as a discipline, but as a door. Maths can be a brake, closing doors, or a "sesame" opening doors. The discipline, and its interest in itself, has disappeared. Harsh words, and a harsh reality as well: in the French curricula system, maths is a tool to select good from bad pupils since decades. It has finally joined its reality; pupils use maths as a support; mathematics is not anymore a discipline, which could be interested and interesting, but a selective object.

FM11 (S) *A chore. It could be fun/excitement. I can understand people who are bored by maths.* FM12 (ES) *I had the feeling to work a lot, and not having good marks.*

FF12 (L) wanted to attend L, and really has to *Fight against teacher to not attend S.* She is an excellent pupil, and, considering teachers, spoiled her future not attending S. FF21 (S) *for those who are in L, some could be interested by sciences, but a lot have a huge problem with maths.* FM22 (ES) *(Are you interested in SET? Yes, but I'm not very good. I'm not good in maths. FM22 I don't like maths. I don't understand it. Teacher says I don't work, it's not true! (Had really good teachers previous years...) Math is no interest! I'm not interested!* FF23 (L) *I have a reject towards maths, physics, chemistry! Those disciplines are useful, but*

this is scientific, so we need concrete proofs. For us, in L, it's not the priority. FM21 (S) I choose S because L, I'm not really literary, and ES doesn't really interest me. I was always interested in sciences. I prefer bio. Chemistry! Experiences are much more interesting. I don't really like maths. Too theoretical! I prefer applying. FF22 (ES) I'm attending ES, and didn't attend S because of maths and physics. I wouldn't feel able to learn all these maths formula. I don't like maths (bad grades, attended ES by default, I wasn't really interested by physics, L, not enough open ways after. Maths is only formula and theorems to learn. Biology is everyday life! (Procreation). In L they have just forgotten it (maths) they're so happy!

The problem of choosing S or not S because you're bad or good in maths raise the problem of Authenticity: you're an authentic scientist or you're not! Very present in the pupils' discourse, this authenticity problem is linked to the difficult problem of job opportunities, whose main impact is the maybe future disappearing of the L section, as it concentrates now the "bad" students, and is repelling others. Good pupils would concentrate in ES or S, even if they're inhibited literary pupils, because of the poor job opportunities of the L section. L is now deserted.

FF11 (L) I choose Literary as a major when I saw that I had really bad grades in maths. I see the work that they expect you to do in S and this is not what I want to do...everyone wants to attend S at school. Because this is where you can, as they say, have more open doors, and a wider possibility of jobs. L would attend preparatory classes, and would become failed writers! And would earn no money! S would rule the world! FM11 (S) I can't really promote S to others. Because you really have to be talented and motivated for that. It's better to do a good ES than an average S final high school exam. FF23 (L) A lot of them attended S because of the opened ways (future jobs/urged by parents). As in L, those who attend L because they were refused in others disciplines (ES/S).

Teachers (FMT21, Biology teacher) are very conscious concerning this difficult job opportunities bias problematic: *There is a piloting by the studies you can do, not the careers! Pupils think short termed. They have understood that they will attend some kind of studies and after, they'll see.* FMT21 frames the problem in the S section itself: FMT21: *We have to demolish S. S would only gather good students in sciences. S is now a fence to the development of scientific careers. The problem of S section is that you have to be good everywhere.*

FMNT2 (French/literature teacher) raises another problem concerning his own discipline: as S section is now gathering all good students (good in all disciplines) L section is now recovering only bad students (refused in S and ES) and a very few of good students, attracted by literature. *L section has now an increasing gap: it gathers bad students, because of the poor job opportunities. The orientation is done by fault, not by taste.* He would talk about the S section corruption: *a lot of pupils would attend S not because they're interested, but because the job opportunities are wider.*

Conclusion.

This peculiar situation provokes serious bias in the orientation choices of French pupils, female and male. In Fact, S pupils, having succeeded their final high school exam, are less and less attracted by scientific studies and jobs. In 1995, 72% of the S pupils leaving Secondary High School chose to attend scientific studies, while only 64% of them chose it in 2001. In 2004, less than 1 pupil on 2 in S had chosen S section mainly because of its interest of scientific disciplines, and 45% of the S pupils having attended Biology as main option would not choose to attend scientific studies after final High School exam. After the S final exam, 42% of the girls, and 31% of the boys, after an S section, would not attend scientific studies (2004, MEN-DEPP).

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<http://www.sfc.fr/SocietesSavantes/4%20-%20Bac%20scientifique.PDF>

Terminology.

FM intends France Male, FF France Female, FF21 France Female second case, number one. FF12 France female first case study, number 2. FMT21 intends France Male Teacher Second case study number 1. FMNT2 intends France Male Non Technology Teacher case study 2.