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Are boys and girls equal before Sciences ?

The search for abstract and speculative truths, for principles and axioms in science, for all that tends to wide generalisation, is beyond a woman's grasp; their studies should be thoroughly practical. It is their business to apply the principles discovered by men, it is their place to make the observations which lead men to discover those principles.

Jean-Jacques Rousseau (1712-1778), *Emile or on Education* (1762, Translated by Barbara Foxley)

From the age of Rousseau, « facts » have proved that women are able to abstraction as are men. But such a statement should express a durable and unconscious state of mind since, in Europe, sciences do not keep pace with women, so the query « For sciences, women are they men as others ? » may still be asked to-day. Indeed, when they choose to study in sciences, girls select more willingly academic scientific studies for health jobs, biology or chemistry, studies which seem less abstract than physics or sciences for the industry.

In France (1), statistical data, are clear. Obviously, women are not men as others for girls differ from boys... however they have better results at 11 than boys and are few to stay in form for two years. Less girls than boys leave school without being graduate (2). In the last year of secondary school, girls (70%) obtain the graduation (*baccalauréat*), 56% boys (3). Then how to explain that, in university, studies depend broadly of genre ? Only 29,5% of girls enter in scientific « classes préparatoires » (1), only 27% of girls are graduate engineer, 30% study in fundamental or applied sciences. But they are a majority in Law, Literature, Social Sciences, Languages, Biology, Medicine and Pharmacy studies. Girls who have a Ph.D. : 54% in Human and Social Sciences but only 35% in Sciences. In 1986, the competitive examination to enter the « Ecole Normale Supérieure » became open to girls and boys (before 1986, two exams, one for girls, one for boys). Immediately the number of girls admitted in Maths and Physics drastically reduced :

1985 : 33% of girls in Maths ; 41,7% in Physics

Between 1986-1992 : 6,8% in Maths ; 17,4% in Physics (4).

Consequently, at least in this case, mixity is a regression and results in a set-back for the access of girls to scientific academic studies.

In Europe (5), young girls leave school less early than young men (13% vs 18%), in particular in countries like Portugal, Cyprus, Spain and Greece, where early leavings are important. At 20, 81% of european young women have got a diploma at the end of high school cycle vs 75% of boys. They remain a minority in Maths, Sciences and Technology.

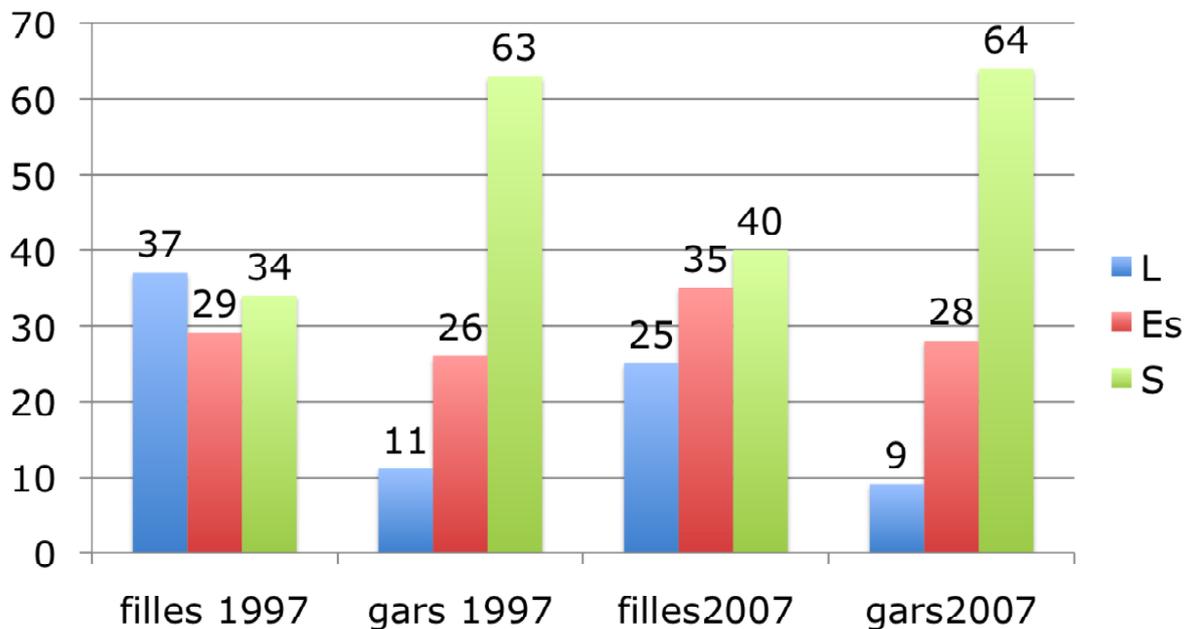
In OECD countries (6), « the number of female students in tertiary education has increased more rapidly than that of males, but the proportion of women choosing Science and Technology studies is still lower than that of men. Furthermore, even if the share has often increased more clearly in countries that had the lowest proportion of female Science and Technology students, trend analysis suggests that the proportion of female Science and Technology graduates may hit a 40% ‘glass ceiling’ even in the most ‘effective’ countries, perhaps due to a selective choice of females for some specific fields » and « in most countries, women constitute less than 25% of computing and engineering students. In contrast, women are systematically more numerous than men in life sciences. »

(Little) improvements

Always in France, between 1997 and 2007, girls, in High schools, have choosen more often than before to study Sciences and Economy than Literature and Languages. But, this is not true in technical schools where choices remained the same.

1997			2007	
Série	Girls	Boys	Girls	Boys
L	37	11	25	9
E	29	26	35	28
S	34	63	40	64
Total	100	100	100	100
STI	3	49	2	48
STT	67	39	67	40
Technology	30	12	31	12
others				
Total	100	100	100	100

L : literature ; E : economy & social ; S : science ; STI : sciences & industrial technics ; STT : sciences & technologies for tertiary sector. (7)



improvements are only a thrill, the main stream always carry away from sciences, particularly applied sciences, girls of 17/18. Choice of studies is therefore gender marked.

Why ?

Researches and surveys are numerous, specially in sociology, trying to explain the complex phenoma of studies choices by girls. They have shown complex interactions between personal experience, personal interest, personal attitudes to sciences and technology and their influence on choice of studies. School and family customs play a determinative part. Huge differences exist, in family education, between girls and boys. For instance, girls receive pink dolls and boys litte red cars ; demands in school results and professional projects of fathers and mothers depend on genre. In classroom, teachers treat girls differently than boys (8). Stereotypes are powerful : boys are seen as self-governing, creative and inattentive ; girls as teachable, affect-governed, attentive and sensitive. In handbooks can be found the same stereotypes : images of women are less numerous than these of men ; women working in agriculture are bending towards earth, when men are standing on ; searchers, engineers, even manual workers, are men. More generally images of women in press and advertising are near caricatures : either loving and/or suffering mothers or sexual objects (roughly exhibited or/and strongly canceled, according to local customs).

On 2008 september, advertisement posters for a big french supermarket could be seen in streets showing, on the left side, a pretty young girl with a dunce's cap and the assonant mention 'more top-model than model pupil' ; on the right side, a young boy demonstrator wawing about a placard telling 'Recycle !' with an equally assonant legend 'One can be a

school boy (in french *écolier*) and an ecologist'. The young girl with bad school results looks away when the bold young boy promotes a cause of public interest.

So, such vivid stereotypes hang on girls and boys, they are modeling, unconsciously, self-consciousness and representations of professional competencies. Girls undervalue their chances of succeeding when boys overvalue. Girls think their failures result of their lack of competencies when boys accuse their teachers or... their proper lack of school working. Relation to learning is different for girls and boys, which means great differences in relation to power. Usually, girls are not encouraged to pursue sciences career paths by their families, their teachers and the career advisors.

By the side of socio-cultural stereotypes influencing girls' choices, surveys in education try to analyse the personal relations of girls and boys with different aspects of sciences. In Germany, researches (9) have shown which differences exist between boys and girls (students between 11 to 16). Girls are less interested by physics than are boys, but the difference is narrowing with increasing age. Usually, physics looks a too abstract science for both girls and boys, and girls show few interest in topics like light, sound and heat, and not interested in mechanics, electricity and radioactivity. Girls appreciate, in physics, its usefulness, its relation to other scholar disciplines and its significance for everyday life and problems. Later, the German researchers draw portraits of three kinds of pupils: 'techno-scientific', 'humanist' and 'citizen'. One quarter of the pupils observed are 'techno-scientist' and boys. They hope in the pursuit of a science and technology career. 'Humanist' represent half of the pupils and like to understand natural phenomena and their influence on human life, they are girls and boys, equally. remain the third profile, 'citizen' who care for the impact of physics on social life and policy, the three quarters of this group are girls.

Another research (10) on out-of-school activities of girls and boys ascertained that boys experience in physics (electronic games, microscopes, rockets) when girls choose experiences with a biological aspect (bird watching, planting, sewing seeds).

Differences in interest for contrasted aspects of sciences are genre-related when the aspects of sciences related with everyday life look appreciated by both girls and boys and stable in terms of age.

Waiting for...

In modern societies, equality between women and men remains puzzling. Nevertheless, beyond stereotypes and social problems exist specific questions about girls and their relations to sciences, for girls do not choose scientific academic studies nor scientific jobs.

In 2002, in Barcelona, Europe had settled to increase its scientific and technical potential of 700 000 persons in 2010...

In high schools and universities, some teachers call for new proceedings, new curricula, new methods so as to show that women are effective everywhere they work and that science is not a men guarded property...

Certainly such actions are - or would be - useful to change minds and choices. But problems continue to exist, as shown precedently by surveys and reports, such as :

- lack of interest for studying sciences increase with duration of scolarity,
- this interest appears before 14,
- girls (as boys) consider studying Physics very difficult and more and more abstract along years,
- girls prefer sciences in human and social context (so they choose Medicine or Agronomy),
- girls prefer group studying and critical debates that they do not find when they study Physics.

... and acting for

So, in England, the Institute of Physics considering that « the number of girls who continue with physics after the age of 16 is a major concern » has been working in this area since since 2006 and has published « Engaging with Girls », an action pack for teachers. Paradoxically, they have worked, first, with girls-only schools, so as to observe how girls can be training to appreciate sciences and obtain best results in examinations. Then, they have used their findings to establish concrete propositions.

They propose change to the physics curriculum informed by an understanding of gender issues completed by a monitoring of the impacts of changes on girls. They promote qualification (and enthusiasm) for Physics teachers « because girls, who often lack familiarity with the situations and activities that are common in physics, require more support to negotiate shared meanings and are therefore more sensitive to poor teaching than boys ». They consider necessary to prepare a physics curriculum developing « student's understanding of how the physics they are learning relates to themselves, impacts on the modern world and opens up a range of professional and technical careers. » And last, « the whole assessment process must not introduce barriers to the participation of girls in physics. » Bad relations between girls and Sciences are not bound to happen. But waiting for change is no solution. If we think « Yes, she can », we have to introduce, actually, concretely, change in schools.

Notes

- (1) *Filles et garçons à l'école sur le chemin de l'égalité*, France, Ministère de l'éducation nationale, DGESCO / DEPP, 2007.
 - (2) *Repères et références statistiques sur les enseignements, la formation et la recherche*. [RERS 2008]. France, Ministère de l'Éducation nationale et ministère de l'Enseignement supérieur et de la Recherche, septembre 2008.
 - (3) Gruel, Louis & Tiphaine, Béatrice, Des meilleures scolarités féminines aux meilleures carrières masculines ; Observatoire national de la Vie Étudiante, Laboratoire d'Économie et de Sciences Sociales de Rennes, Université de Rennes 2, avril 2004.
 - (4) Ferrand Michèle & Imbert Françoise, « Physiciens, physiciennes : une enquête auprès des normaliens et normaliennes scientifiques », *Didaskalia*. Supplément au n° 3. 75-85, 1994.
 - (5) (Rosenwald Fabienne), *La réussite scolaire des femmes et des hommes en Europe*, Les notes d'information, France, D.E.P.P., n° 08.11, février 2008.
 - (6) *Evolution of Student Interest in Science and Technology Studies Policy Report*, Organisation for Economic Co-operation and Development Global Science Forum, 4 may 2006.
 - (7) Sylvie Lemaire, Delphine Perelmuter, *Les bacheliers S et STI : évolutions récentes et choix d'orientation dans l'enseignement supérieur*, France, Ministère de l'Éducation Nationale, DEPP (colloque action sciences avril 2008).
 - (8) Mosconi Nicole, Loudet-Verdier Josette, « Inégalités de traitement entre les filles et les garçons », in Blanchard-Laville Claudine (dir), *Variations sur une leçon de mathématiques. Analyse d'une séquence : « L'écriture des grands nombres*, Paris, 1997.
 - (9) Häussler Peter, « Measuring students' interest in physics-design and results of a cross study in the Federal Republic of Germany », *International Journal of Science Education*, 9 (1), 1987.
- Häussler Peter, Hoffman Lore, Langeheine Rolf, Rost Jurgen and Slevers Knud, « A typology of students' interest in physics and the distribution of gender and age within each type », *International Journal of Science Education*, 20 (2), 1998.
- (10) Jones M. Gail, Howe Ann, Rua Melissa, « Gender differences in students' experiences, interests, and attitudes toward science and scientists », *Science Education*, 84, 2000.