

Cultural differences of female enrollment in tertiary education in Computer Science

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Abstract: Since the establishment of computer science courses in the last 30-40 years both female enrollment and its development differ strongly between various continents, countries, cultures, religions and languages. It is remarkable that female participation is extremely low in German (and Dutch) speaking countries, in Scandinavian countries and Great Britain, compared to the other European countries. In many Western countries female participation in computer science courses has dropped since 1970 by more than 50 percent. This has not occurred in semi-developed countries, like the South American ones, the rich Arab countries, the Tiger states or India, nor has it occurred in the developmental countries in Africa.

Within our cultures the values of gender equality, freedom and deconstruction of gender differences often are used as arguments for a naturalization of these gender segregations in professions. But the observation of the differences in various cultures shows clearly that there are no inherent, but contingent reasons for such segregations. For example within the new countries of Germany it can be observed what effects reunion had on the female enrollment in computer science.

In this paper after showing the numbers of female enrollment in tertiary education in Computer Science in various countries I want to give explanations and theories for these differences. It will turn out that there is no evidence for natural explanations of competence and interest in computing, as well as in mathematical and technical subjects. The findings in turn may give hints how to change the situation of women in Computing within our culture.

Key words: female enrollment in computer science courses

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1. SOME EXAMPLES OF FEMALE ENROLLMENT IN COMPUTER SCIENCE

A quick glance at the proportion of female participation in science and engineering throughout the world (Table 1) reveals the extent to which gender distribution is culturally diversified. It is interesting to note that many of the so called industrially developed countries are comparatively underdeveloped as far as the inclusion of women into these subjects is concerned. Another interesting observation is that within Europe the former socialist countries have had and the Latin countries are having a much higher female participation in science and engineering than the Anglo-Saxon, Scandinavian and German speaking countries. Within Europe Turkey, Spain and Portugal are doing best with respect to the inclusion of females in science and engineering in all stages of the career ladder. Also it is striking to note, that quite a lot of African, all the Arabic and South American countries have a nearly equal gender distribution in Computer Science.

Mathematics/computer science

Country	Total	%F
Angola	na	na
Burkina Faso	433	5
Burundi	77	34
Ethiopia	468	9
Ghana	206	11
Kenya	na	na
Lesotho	na	na
Niger	na	na
Swaziland	na	na
Uganda	155	10
Zambia	na	na
Zimbabwe	na	na
Kuwait	1635	72
Brazil	70898	38
Mexiko	51751	41
Sweden	6504	19

na = not available because subsumed under another faculty

Figure 2. Enrollment* for selected countries, showing total number of students and the percentage representation of females; Figures given represent enrollment in courses leading to a first degree. Source: compiled from the UNESCO Statistical Yearbook, 1993.

Some actual numbers from some single Universities show the striking differences as well (information by Joel C. Adams, Ph.D., who gives lectures in Mauritius 2001):

University of Mauritius: 40-50% women in CS courses

National University of Samoa: 60% of CS students are women.

2. THE GERMAN SITUATION IN INFORMATICS

There has been a constant rise in students' enrollment since the nineteen seventies. But the female participation has not gone together with the male one. During the eighties and nineties the fraction of females even decreased substantially. In contrast the female participation in the former GDR was equally distributed among the sexes. After the reunion of Germany, the participation of women in the new German countries from former East Germany have dropped to West German level. The following tables are showing the incredible degree of decline of females in Informatics within the new countries. Similar effects have occurred in Hungary (according to a colleague in Budapest ca 10% at the university of Budapest in 2000), but not in all of the former socialist countries.

3. THE SHRINKING PIPELINE

A different, but also context dependent effect is the shrinking of female enrollment in Computer Science in some countries, like the USA [Ca 97], in German (and Dutch) speaking countries, in Scandinavian countries and Great Britain and in Israel, often in contrast to all other subjects. In general in Western countries the interest in science and technology is sinking in second and third level education. Rising numbers are only seen in China, India and in the four Tiger countries. Within this general trend female percentages in western societies are rising in proportion within these subjects. But even in this general situation female participation has fallen in Computer Science since 1985, e.g. in Germany up to a half or more.

Year	Enrollments			New Admissions			Graduates		
	Total	Women	W as %	Total	Women	W as %	Total	Women	W as %
1969	350	265	75.71%	309	228	73.79%			
1970	921	438	47.56%	459	192	41.83%	0	0	
1971	1353	644	47.60%	465	219	47.10%	0	0	
1972	1637	853	52.11%	376	261	69.41%	51	34	66.67%
1973	1445	810	56.06%	260	179	68.85%	393	190	48.35%
1974	1253	766	61.13%	280	166	59.29%	406	175	43.10%
1975	1071	674	62.93%	261	141	54.02%	386	206	53.37%
1976	932	543	58.26%	218	97	44.50%	301	202	67.11%
1977	841	442	52.56%	167	81	48.50%	224	162	72.32%
1978	736	349	47.42%	157	65	41.40%	239	146	61.09%
1979	688	315	45.78%	120	69	57.50%	138	88	63.77%
1980	583	297	50.94%	145	80	55.17%	205	73	35.61%
1981	550	299	54.36%	148	96	64.86%	155	76	49.03%
1982	633	349	55.13%	214	126	58.88%	104	57	54.81%
1983	710	418	58.87%	233	146	62.66%	1101	51	46.36%
1984									
1985	1024	550	53.71%	351	189	53.85%	129	74	57.36%
1986	1338	732	54.71%	500	296	59.20%	124	75	60.48%
Total				4663	2631	56.42%	2965	160	54.27%

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Figure 2. Full-Time all GDR University Computer Science (Informationsverarbeitung), Majors 1969-86; Source: Dolores L. Augustine

There has been no such effect in the Latin countries at the same time. In other countries, like Turkey, where the number of women taking computer education was constantly high, a decline has started later at the end of the nineties, probably due to the introduction of the Internet (personal information by a Turkish colleague).

		All	Female	% of female CS-students
WS	1986/87	60	39	65,00%
WS	1987/88	60	39	65,00%
WS	1988/89	133	49	36,84 %
WS	1989/90	205	65	31,70 %
WS	1990/91	241	49	20,33%
WS	1991/92	241	43	17,84 %
WS	1992/93	261	44	16,86 %
WS	1993/94	255	39	15,29 %
WS	1994/95	236	36	15,25 %
WS	1995/96	262	31	11,83 %
WS	1996/97	294	25	8,50 %
WS	1997/98	324	28	8,64 %
WS	1998/99	359	30	8,36 %

Figure 3. Effects of the reunion of Germany on the female enrollment in Computer Science at the Technical University of Rostock (source University of Rostock)

The German female enrollment in CS shows the shrinking effect through the last 15 years, but it also shows a slight improvement during the last two years (the latter, although highly appreciated, is not yet understood: it could be a result of the enforcement of the labor market due to the lack of computer professionals in Germany, and/or of the summer university Informatica Feminale in Bremen, which gives women a lot of encouragement, the more diversified Informatics courses, with possibilities for interdisciplinarity, and/or of the rising availability of computers in families, also for girls, and/or of the new and more social qualities of software, availability of better computer games , etc.).

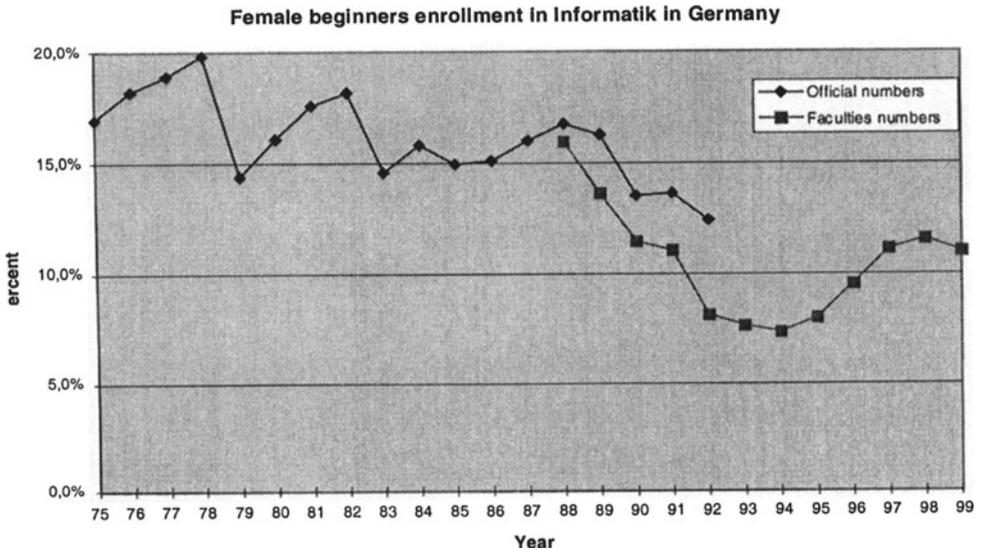


Figure 4. Sources: BMFT, Fakultätentag Informatik; own representation

4. ADDITIONAL DIVERSIFICATION OF FEMALE ENROLMENT ACCORDING TO UNIVERSITY TYPES

Tracy Camp found that graduates in CS in engineering colleges, on an average, have proportionally fewer women than in non-engineering colleges. On the other hand at the level of Ph.D. degrees the percentages, though still meagre, increased. This is observed since more than 10 years in the US. We find that the same effect has occurred recently in Germany as well, with Technical Universities as opposed to classical (Humboldt) universities and especially to interdisciplinary courses of study in Informatics – and that the percentage of female assistants willing to achieve a Ph.D. in Informatics is often larger than the percentage of Informatics students.

More specialized courses recently are showing significant particularization effects of gender differences as well: the more technically defined (i.e. named) the less female participation and the more interdisciplinary and application defined, the larger the female participation (e.g.: FH Furtwangen 2000/01: Technical Informatics 0,0% females, Media Informatics 27,8% females).

We have recently investigated the participation of women in IT work force as well as at all types of tertiary education within the province of Baden-Württemberg. Especially on the educational sector there is a strong dependency on contexts. The more emphasis in “dressing” and description is put on technology and engineering, the less women are interested, the more the subject is considered as interdisciplinary, the more it is put into social context, the more women are participating, even if the very subject is mostly technical (like media informatics).

5. INTERPRETATIONS OF GENDER DIFFERENCES IN COMPUTER SCIENCE BETWEEN DIFFERENT CULTURES

The factors attributed to the diversification of gender differences existing between the “industrially developed”, the “semi-developed” countries, like the South East Asian and the South American ones and the “developmental” countries, like the south Sahara African countries also include the class system, the different roles of universities, and the rate of income in science and engineering.

The class system has been predominant in the “semi-developed” countries (like India, Brazil or Argentina), where only the upper class people could afford to send their children to university and they equally let their boys and girls to study. Especially in these countries, there seems to be no conviction like in the North-West, stereotyping women as less capable of pursuing education in science and technology. Another important factor there is that household and childcare works which are supposed to be the spheres of the females are delegated to employees, a fact which enables these women to join in the labour market with commitment just like men. Moreover, it is presumed (wrongly, as is obvious e.g. for India or Korea) that the university standards are considered to be not as competitive and high as in the “industrially developed” countries, making the courses of study less hard and stressful. Besides, the emphasis of these universities is supposed to lie more on educational than on scientific level, a circumstance which poses studying and university careers closer to standard female gender roles. As a consequence the teaching personnel in these countries is less gender diversified, giving role models for women as well. But again India and the four Tiger states cannot be put into this scheme and it is quite ironic to note that especially in these countries there seem to be strong differences with regard to cultural/symbolical constructions of gender.

The extremely high participation of women in engineering and computer science within the *North African and the Arab countries* can on the one hand be explained by the different subject-specific gendering: religion is a male enterprise, but technology is not gendered. But on the other hand also the gender splitting might be of importance: There is no coeducation on any level of education in these countries. That coeducation, especially during puberty, hurts female participation in science and engineering is widely explored, especially in the north-western countries of Europe and America. But it is important to note that it does not hurt everywhere (e.g. Italy)!

In Spain and Portugal also transition to democracy within the seventies and eighties has played an important role for the change of the role of woman in society. The massive intrusion of women into the educational sector came within a time period, where work power for the technological sector was extremely demanded. This explains the growth of female participation in technical studies within the eighties.

The very high participation of women in technology in the former *socialist countries* is giving rise to a different complex of causes and explanations. There gender equality was always pronounced (although a glass ceiling also existed in a more subtle way [Au 99]), whole day kindergartens existed for every child and 98% of all women in the respective age class worked. Until the nineteen hundred-eighties the stream of students was directed according to communist ideals, like future technologies and gender equality, but also to the needs of the work market. Of course this also forced many women into science, mathematics and technology, contrary to their interest, as Dolores Augustine rightly observes. Also at schools more emphasis was put onto science and engineering than in the west and all pupils could gain experiences with technology by the obligatory training in "polytechnic education" in firms [Ha 92]. Among others, Breckler *et al.* have found that the practical acquaintance with technology is extremely important to find interest, experience and finally also to decide for a respective profession [Br 91]. All this might explain why so many women were studying Informatics.

But why did the percentage collapse immediately after reunion? This is easily explained: there was an explicit policy to draw women from the job market. Kindergartens were closed, (from the "old countries of Germany" imported) politicians declared that female work had to reduce to a "normal" (i.e. West German) size. From 1990-1992 most jobs in the former DDR were evaluated (abgewickelt), a procedure where most people lost their jobs. In engineering men regained their other jobs, women not [Bu 97]. Of course this was not encouraging for taking up a study in Informatik or engineering. The effect is the one which was sought for.

Particularly interesting and difficult to explain are the considerable differences within Europe, which show less gender segregation in the Latin and the Slavonic countries, as well as in Turkey, than in Great Britain, the Scandinavian and the German speaking countries. These facts are directing attention away from structural reasons towards differences in the symbolic meaning of the gender - technology relation. This might give explanations for the diversification according to the types of Universities in Germany as well.

There seems to exist a deeply founded desire to “perform gender” in some way or the other. If gender differences are institutionally guaranteed or culturally fixed, as it may also be performed by a visible marking, like dressing order or hairstyle/beard, or by a clear hierarchy within family work this performance of gender difference can be satisfied without a gender marking of competence. This seems to hold also for the Catholic Latin and Slavic cultures within Europe, where a stronger body performance of gender is shown than in the Protestant cultures. In the Catholic countries there exist more specified gender cultures, which allow the individuals of both sexes self - conscious gender identities. This cultured behaviour is performed mainly in social interaction between men and women off workplace and it confirms their respective self-esteem as women or men. At the Balkan and in Italy, Spain and Portugal, there exist very distinctive and self confident gender cultures, both concerning the role of mothers of all generations and amongst the youth meeting and showing off at open places. In Russia the common conviction that men are incapable of organizing everyday life (and often also the professional life) gives women a fairly self conscious gender identity, still not putting differences into question. So there is no necessity for boys or men to hold their ground in mathematics, science or engineering to stabilize their male identity and women can more easily consider themselves of equal intellectual ability, including fields like computer science. They need not take distance from engineering and IT to perform femaleness, as it is often observed in the North-Western European countries.

Within the Protestant cultures there is a greater tendency to hide body and sex, to equalize dressing and large parts of the habitué. With the additional dissolving of gender differences in law and other institutionalised forms gender difference has appeared somewhere else. Societies tend to uphold gender hierarchies by reproducing gendering, especially in highly respected fields, like IT. Therefore it appears that there exists a need in the latter cultures to create the difference individually and by deliberate action and that this action has to be marked symbolically. As a consequence gender differences evolve context dependently, and their creation becomes a process with many prerequisites bound to specific constellations and to different areas of human activity. Therefore in certain contexts gender differences can

be dissolved whereas in other ones they can be maintained or even be strengthened, like it is the case within the higher valued IT job market in some areas of the world. Though gender as a factor of ordering society seems to lose its importance in the north-western European countries in general, it shows considerable persistence with respect to hierarchical structures, and it even gains importance on the symbolic level for the ordering of content, of scientific subjects, of specific professions. The contextualisation of gender difference might be caused by the open space, leaving the definition of gender identity much more to chance and to the individual. Unfortunately this free space frequently is not used in the sense of creating an identity which includes equal value. The gendering of competence creates a symbolic gendering of subjects, and with this also borderlines between and social closures for men and women.

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