ibw-research brief

Ausgabe Nr. 07 | September 2004

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Gender-specific aspects of access to courses and professions in the field of science and technology - an international comparative analysis

ABRIGED VERSION OF THE STUDY

It is one of the central challenges for Austria's educational policy to secure a sufficient amount of human resources to put into practice the innovative political aims in Austria. Moreover, we know from comparative studies with Scandinavian and Anglo-Saxon countries that these succeed much better in recruiting women for jobs in the field of technology and science than Austria does. The Industrialist Union (IU) thus asked the *ibw* to analyse the reasons for the sex-specific access to these fields of knowledge and work, which are going to be decisive in the future, as well as to make recommendations in the form of a detailed strategy.

At the outset of the investigation was the idea that a society based on knowledge gets more and more disadvantaged with respect to social and economic development, if it does not optimise the chances for access to technology/science studies and professions for girls and women alike. These disadvantages will especially occur in comparison to countries that do better in this respect. One of the European Union's five benchmarks in the field of education for the aims until the year 2010 corresponds to this: "By 2010, all Member States will have at least halved the level of gender imbalance among graduates in mathematics, science and technology, whilst securing an overall significant increase of the total number of graduates compared to the year 2000" (InfoBase Europe, Record 6820, 07 May 2003, Education policy).

Comparing with the best

Starting from a comparison with the countries that have the highest percentage of female technology and science graduates, differences in the education systems are tracked from the tertiary down to the secondary level.

Of the 8.2 million natural science and engineering graduates in the Member States of the European Union, about 31 percent were women in 2002. In some countries, however, these figures were significantly higher: in Finland, Ireland and Belgium, parity has been reached; in Sweden, women make up more than 40 percent, and in Great Britain, the percentage of women in these jobs is slightly below that. Austria was below the average with 27 percent females in the abovementioned professions. The percentage of technology and science people among the whole workforce was 5.1 percent on average in the EU – in Austria it was 2.2 percent. A comparison between the countries reveals that high percentages of female graduates in natural sciences and engineering can more easily be achieved if the potential of women is promoted also in these fields of knowledge, both during training and on the job, and if obstacles are torn down.

FIGURE 1:

Benchmarking: human resources in technology and science, 2000

Country	Female graduates of natural sciences and engineering in percent of all people in jobs	*Percentage of women*
Finland	9.0	*52*
Ireland	8.1	*51*
United Kingdom	7.l5	*37*
Belgium	7.3	*50*
Sweden	5.7	*42*
Austria	***2.2***	***27***

Source: Eurostat 2002, as well as our own calculations

If one compares the countries, a positive aspect catches the eye first: regarding the percentage of women in the fields of biological, natural, and agricultural science, Austria holds a position above the international average (4 percent above the average of 48 percent females).

Yet, the number of women in **mathematics and computer science** (18%) is far below average; Swedish and Finnish women do best in this respect and make up 39% , and 35% respectively, of all graduates each year.

In the classical engineering sciences, the percentage of females in Austria (17 percent) is 5 percent below the average and thus smaller than in maths and computer science. Again, the Swedish women excel with 28 percent.

A gender-specific drop-out problem at Austria's universities with long studies

Among university freshmen, women have achieved a majority in science. In the field of food and biotechnology –an area with a future- women make up almost 60 percent of all beginners today. In summation, approximately one fourth of all freshmen in technology and engineering are female - both at universities and specialised tertiary colleges.

In university studies that take rather long, the percentage of women who succeed is relatively low in comparison with men; yet, this does not apply to their success in shorter studies.

At specialised tertiary colleges, the number of female students of technology and engineering is not higher than at universities, but one cannot identify a lower graduation percentage.

Growing female participation in secondary schooling – technology remains on a low level

Over the last decades, Austria has proven impressively how the inclusion of girls into secondary schooling as such can be a success. As a result, questions of a need-oriented choice of tertiary studies are being raised. Thus the question will have to be asked, to what extent Austrian secondary schools (both at lower and upper level) succeed in getting across and promoting interest and the prerequisites for knowledge, so that the growing percentage of female university freshmen (45 percent in 2003) will also be directed into those areas of education which promise good job perspectives and a good income in tomorrow's technological economy and society.

PISA-2000: the differences between boys and girls in mathematics are bigger in Austria than anywhere else in Europe

The fact that secondary schools have a preparatory function has become the topic of critical reflection - thanks to extensive international comparative studies. Even though the results of PISA 2000 have been discussed a lot in public, the fact that no other country displays such a huge gap between the maths performance of boys and girls as Austria, did not cause much of a stir. The girls' test results for maths in Austria was 27 percent lower on average than the boys' results (with a an average difference of 11 percent in the EU); in science, the girls did 12 percent worse than the boys (with the EU average being exactly zero).

TIMSS-survey of 1995: compared to other countries, Austria's girls lose ground on upper secondary level

Even though they were less recognized, the results of the TIMSS survey of 1995 are no less important than those of the PISA 2000 study: Austria's girls hold a good position internationally in maths and science in eighth grade, but they lose it by the end of upper secondary level – while Swedish and Dutch girls maintain their good position or get better on upper secondary level.

Is there a deeply rooted, traditional discrimination against maths and technical sciences in Austria's advanced general secondary schools?

Specialists in teaching as well as resources for further training will be needed, if one wants to unfold talent in maths and science all across secondary schools, or to lead the way at schools with special focus to achieve 'critical mass'.

It remains to be seen whether the experts needed are actually available. It is a fact though that an extreme disproportion can be seen from the distribution of subjects among teaching graduates. In the mid 80s (i.e., the graduation years of the teachers who are presently in their mid working years), there were –judging from the graduate numbers- too few specialised qualified teachers in Maths, Chemistry and Physics compared to other subjects; not enough to get to the 'critical mass' necessary to achieve diversity in fostering, or to develop interesting foci and projects.

A simple comparison of the output of teaching diploma examinations per academic year adds weight to these concerns: the class of 1985/86 saw 792 successful teaching diploma examinations in the core subjects of the arts and humanities (366 in German, 340 in History, and 86 in Philosophy, Pedagogy and Psychology) on the one hand, and 247 such examinations in the core subjects of maths and science (149 in Mathematics, 78 in Physics, and 20 in Chemistry). The first field thus had three times as many graduates as the second. (Federal Ministry of Science and Research: statistical yearbook, Vienna: 1987, p.52).

Even if there were subject-specific employment figures available (which is, unfortunately, not the case), the question would still remain: is the quantitative potential for interesting classes, to acquire the fundamental qualifications in the core subjects of mathematics and science, available to the same extent as in other core subjects?

In the year 2000/01, the percentages of the core subjects in technology and science were still rather low, even if one could see a slight tendency towards a more balanced distribution. There were 71 teaching diploma examinations successfully taken in Maths, 28 in Physics, and 12 in Chemistry, which amounts to a total of 112; German saw 120 of these, History 110, and Philosophy, Pedagogy and Psychology 35 – which is in total 265 exams that were successfully taken. (Austria Statistics, university statistics 2001/02, Vienna: 2003, p. 204ff). The following two questions are to be investigated in light of the potential of teachers: first, the question of expertise in teaching, especially on lower secondary level; and second, the prerequisites for promotion on all levels and for foci according to the respective subjects on upper secondary level.

It would also make sense to develop concepts for so-called **Centres of Excellence** in science, maths, and technology – also in advanced general secondary schools. Furthermore, we should think about re-positioning the subject Physics under the name of "Physics and technology". Extensive international studies have shown that in the case of schools, cognitive competence and development on the one hand, and fostering of interests on the other hand, are closely linked to each other. This is a didactic challenge to teacher training both at university as well as in further on-the-job training.

The objection is justified that school is not the reason for the differences between how youngsters in Austria and the Scandinavian countries handle science and technology. Much more, deeply-rooted traditional roles in the respective societies can be identified. Still, school education provides an important starting point for any changes in society and employment. How companies play their part and what exactly their possibilities are I would like to mention later.

Clearing out the curriculum on upper secondary level

The changes on tertiary level (specialised tertiary colleges, bachelor studies, etc.) and the international trend towards a 'teritarisation' of on-the-job training, which can also be seen in Austria, should be reason enough to clear out and rethink the various curriculi on secondary level; moreover, these changes should create more open space for interesting teaching. Thus, we could on the one hand gain precious space to learn and develop basic qualifications for a knowledge-based economy (reading, writing, fundamental knowledge in technology and science, etc.), and on the other hand make use of these in the sense on an overdue gender-sensitive differentiation. Without the modernisation of the curriculum (which would account for the long-term international trends towards a 'tertiarisation' of job preparation), one of the strengths of our school system could be turned upside down and become a long-term disadvantage as regards innovation and international competitiveness: our high degree of differentiation on upper secondary level, which allows for an early entry into the labour market.

Preparational courses for special studies

The high degree of specialisation on our upper secondary level may cause starting problems among those who decide to study maths, physics, or chemistry at university. This is because we simply cannot assume that youngsters do not change their plans for university after the age of 14 any more – thus, we should think about creating possibilities for them to change at the beginning of tertiary level.

Monitoring studies and careers

Universities should establish a system to monitor and track the various careers of their students so as to identify the reasons for students to drop out and offer services on demand (such as more flexible opening hours, child care facilities, etc.).

Studies which are flexible in time and modular in nature

Implementing a three-level system in technology and science should significantly raise the chances for success, as the students should graduate for the first time after 3 to 4 years (unlike the present average of 7 to 8 years). Moreover, modular studies can be offered for people in jobs.

Doctoral grants for women

Doctoral graduations are a major tool to promote women's access to professions in science and technology, as well as in research and development. The relative number of people in R&D jobs is high, and so is the number of students that do a doctoral thesis in science and technology. Yet, the percentage of women among all doctoral graduations in science and technology in Austria (22%) is clearly below the corresponding percentages in the leading countries such as Sweden (34 percent women) or the United Kingdom (33 per cent) – both of them being countries that spend a lot of money on R&D and have more female graduates in this field.

Growth of the Research and Development sector as a long-term hope for job creation and as a source for role models

To put into practice the aim to increase R&D spending in Austria to three percent of the GNP would mean to reach a new level of research standards.

The research sector would influence our school system as well as our universities thanks to new qualities and quantities; moreover, it would make creative R&D jobs more easily accessible and attractive for a broader public. This is the place for career and job advice to start.

Roles and possibilities of companies

The long-term development of an economy and a society that intensively do R&D leads to the following question: what possibilities do companies have to motivate and foster girls and women as regards their access to jobs and studies in science and technology? If we take educational biography as a means of structuring, we would have to list the following:

- Contacts to schools, students and teaching staff; being ready to make school excursions to companies
- Expert lectures at schools and in the course of education information in general (which would involve sending successful women from R&D to promote their image and to construct role models)
- Common projects with youths and in further teacher training (both in the company or at educational institutions)
- Patronages for "virtual companies and research laboratories" also for advanced secondary general schools
- Promoting new Centres of Excellence 'science and technology' at schools and maintaining contact with them
- Flexible working hours and part time jobs so as to make accompanying studies possible
- Subject-related cooperation on the level of dissertations and doctoral theses with both universities and specialised tertiary colleges
- Supporting lifelong learning concepts of further training in cooperation with universities with a view to satisfying the specific needs of the female workforce.

This research brief is a short version of the study under the same title *Education and Economy No. 28*
Download: http://www.ibw.at/html/buw/BW28.pdf

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