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The Future of Higher Education Programmes in Technology and the Sciences

Study Rates, Labour Market Prospects of Specialisations, and Approaches to Promote Technological Qualifications

Company surveys conducted in recent years reveal labour market shortages in the recruitment of HE graduates with technological qualifications. This gap is surprising at first sight when taking into account the annual number of graduations in technology and the sciences from about 2,900 to some 5,800 since the mid 1990s. The growth in graduate figures was *not due to demographic developments* but to an increase in study and graduation rates. Thus, the number of first graduations in technology and the sciences as a share in 25-to-29-year-olds rose from 2.1 percent in 1994/95 to over 5.7 percent in 2004/05. This study aims to shed some light on this contradiction by conducting more in-depth empirical analyses about trends in the HE sector and in the employment situation in technology and the sciences and, subsequently, show approaches to promote qualifications of relevance for innovation in short- and long-term perspectives.

The growth in annual graduate figures mostly came about after the introduction of the Fachhochschule (FH) sector and increases in Informatics/Telematics and Architecture in technological and scientific study programmes at universities, and to a minor extent or not at all in the core branches of industry-oriented technology programmes at universities. This affects the following programmes: Mechanical Engineering, Electrical Engineering, Technical Physics, Technical Chemistry, and Technical Mathematics. At the same time, analyses of vacancies and company surveys reveal good employment and career prospects particularly for graduates of the following specialisations: Mechanical Engineering, Electrical Engineering, Metallurgy and Material Sciences, and Informatics. With the exception of Informatics, however, the mentioned programmes are not among the winners of the expansion of the HE sector over the past decade.

The growth in the annual number of graduates at the Leoben *University of Mining and Metallurgy* compared to 1994/95 is due to the relatively new programmes *Industrial Environmental Protection, Disposal and Recycling* as well as *Petroleum Engineering*, whereas there has been no or only minimal growth in programmes for which there is a relatively strong demand in the labour market (*Plastics Engineering*, *Material Sciences* and *Metallurgy*).

The relatively strong increase in the number of graduates of scientific programmes has mainly been due to the programme *Biology*. The number of graduates in the "classic" scientific subjects *Mathematics, Physics* and *Chemistry* has stagnated, however, or has even declined as against the mid-1990s, for example. In the last statistically documented year group, Physics and Chemistry combined came to only 115 diplomas, whereas 103 and 667 graduations were counted in Nutrition Science and Biology, respectively.

Biology is a special case insofar as there is demand in the labour market both for Food and Biotechnology and for Biomedicine and Biotechnology. This is an indicator for the heterogeneity of the studies and employment options open to biologists in the business sphere, which is also revealed in a very informative current survey among young graduates. Employment prospects for "technically" qualified biologists (e.g. Molecular and Microbiology, Biotechnology, Genetics) can be rated as far more favourable than those with a zoological or ecological orientation (cf. Mosberger, Salfinger, Kreiml, Putz, Schopf, 2007).

TABLE 1:

Diploma study graduations and new students by programmes

Type of HE institution, group of study programmes	Graduations 2004/2005	New students** WS 2005/2006	Projection: Graduations rounded*
Technology (FH)	**1,830**	**3,550**	**2,663**
Economic Sciences (FH)	2,031	3,700	2,775
Social Sciences (FH)	162	738	554
Military (FH)	85	98	74
Design, Arts (FH)	109	103	77
Fachhochschule programmes total	4,217	8,189	6,142
Technology (excl. Informatics and Architecture)	**1,307**	**2,605**	**1,560**
Informatics	**605**	**997**	**560**
Architecture	**462**	**798**	**480**
Mining and Metallurgy	**163**	**329**	**200**
Natural Resources and Applied Life Sciences	**361**	**955**	**570**
Sciences (excl. Biology, Psychology and Sports Sciences)	**973**	**2,129**	**1,280**
Biology (incl. Horse Sciences)	**714**	**1,144**	**690**
Economic Sciences (Social Sciences Faculty without Sociology)	4,327	5,934	3,560
Sociology	72	346	210
Law	1,413	3,193	1,920
Theology	187	206	120
Humanities	2,508	8,087	4,850
Pedagogy, Psychology, Journalism, Sports Sciences	2,476	4,023	2,410
Medicine	1,712	3,134	1,880
Veterinary Medicine	149	191	120
Individual Diploma Study	166	518	310
University** total	17,595	34,589	20,750
Both types of HE institutions	21,812	42,778	26,862

* estimate on the basis of success rates (university: 60%, FH: 75%); due to the reference to entrants in the winter semester, this number is slightly underestimated, however.

** documented studies

Source: Statistics Austria, University Statistics 2005/2006

Fachhochschule programmes address a wider range of potential students than universities. Since their creation in 1994, the number of first graduates in technological Fachhochschule programmes has increased continually to slightly less than 3,700 in the 2005/06 academic year. This is due to the following factors: the regional spread of study provision (so far, some one hundred technological Fachhochschule programmes), the opening up for new forms of HE access (14 percent), tailored programmes for people in employment, and the clearly higher share of older people among study entrants, which is due to the above-mentioned factors (winter semester 2005/06: more than 29 percent are 25 or above, as compared to 10 percent at scientific universities). Taking into account the influx to FH programmes, the number of graduates is expected to rise even more. On the basis of entrants figures it can be estimated that the graduates figures in the FH-based technology sector will be between 2,600 and 2,700 in the 2009/10 year group. In terms of specialisations, the output is becoming wider, with a

pronounced share of technological and scientific combinations.

The shortage of graduates of technology from the viewpoint of enterprises in the manufacturing sector is an indirect result of the manifold employment and career opportunities of graduates in technology and the sciences. As they have options in various sectors and occupations, the specific pool of candidates decreases. Although the last census still counted the majority of people in employment with an HE qualification in technology and the sciences in the manufacturing sector, there is a proven trend towards the services sector in all analysed specialisations as against 1991. With the exception of the sciences (more than 40 percent in teaching professions) and pharmacy (80 percent in the retail sector), mainly the shares of company-related services have increased. Considerable shares of graduates with a technological HE qualification additionally reach management functions, which is accelerating substitute demand at the level of technological and scientific professionals.

Company surveys and interviews with staff agencies equally point towards a lack of regional mobility as an inhibiting recruitment factor. The older and the more connected with Vienna, the less pronounced is the graduates' readiness to be mobile; online leadership functions are incentive enough for them to go to "distant lands" if they boast relevant language skills. The engineers' deficits are their foreign language skills, followed by the lack of certain special subject focuses. SMEs more often than large enterprises perceive the graduates' excessive salary expectations and lack of practice-orientation as recruitment problems. Small enterprises additionally criticise more frequently their "exaggerated opinions of themselves" and "lack of adaptability".

Good opportunities for graduates in technology-relevant studies can be expected in the long term. What can be done to promote young talents in these sectors?

- Information and guidance are effective in the short term,
- modernisation efforts of study provision have at least medium-term effects, and
- improvements in the school system on which HE education builds can only have long-term effects.

Improved guidance and well-founded information

Public discussions about good employment opportunities in specific engineering sciences have led to a noticeable change in the study-selection behaviour: In Mechanical Engineering e.g. the number of beginners increased from 208 in the 1995/96 academic year to 353 in the 2003/04 academic year. More frequently than other specialisations, students in the sciences perceive they have been influenced by their school teachers. The impact of institutionalised educational guidance is seen as very insignificant by young people. In a 2004 survey, a rather modest result was obtained for the role of institutionalised educational guidance (a mean value of 4.6 in a rating scale from 1 = decisive role to 5 = no role). The minor role of educational guidance could be connected with a lack of individualised counselling provision and of empirically founded information. The possibilities of current online-based information tools should be extended and increasingly used.

Modernisation of study provision: Encouraging a comprehensive strategy for technological education at the tertiary level

With the introduction of graded HE study programmes and graduations (bachelor and master), Austrian engineering education will move closer to international structures. In 2005/06, as many as 47 percent of FH entrants were enrolled in bachelor courses. This shortens the curricular distance between colleges of engineering (CEs) and an FH bachelor (e.g. post-secondary VET course: 2 years, FH: 3 years). In order to optimally promote technology-relevant human resources in our country, cooperation and an overall strategy are becoming increasingly important, not least to promote international transparency and comparability of qualifications including credit transfer.

The CEs, FHs and universities have their specific opportunities and strengths. Fachhochschule programmes cannot replace universities in the technology sector. As only universities provide for the research-intensive level of doctorate programmes, FHs are largely connected with them in terms of staff recruitment and knowledge transfer. Therefore, regional strategies cannot exclusively build on Fachhochschule programmes, also university sites for technological research and instruction are becoming more relevant than ever before. A conspicuous phenomenon, for example, is the lack of Mechanical Engineering in the university-based teaching and research context apart from Vienna and Graz in view of considerable relevant demand for these qualifications in Upper Austria and the western provinces.

Experimental teaching at secondary school level as an effective lever in the long term

Last but not least, it is important to underline that the secondary school system lays the foundation for interest in technology-relevant studies and related skills. In this connection, a marked imbalance in the annual figure of teaching diplomas can be noted between scientific and humanistic subjects. For lack of teachers, Chemistry e.g. is mainly taught by teachers of Biology and moreover introduced as a school subject at an unfavourable point in time. There are insufficient staff and time resources to provide classes in Physics and Chemistry with the required *experimental quality*, for which particularly qualified teachers and small groups would be necessary. This picture is complemented by international findings (PISA 2003) about the inadequate motivation for Mathematics among young adults. Even if this problematic situation is highly complex and can be tackled by didactics only in the long term, it undoubtedly represents one of the major challenges of secondary school reform in Austria.

TABLE 2:

First degrees in scientific diploma studies for teachers in 5 year groups; Austrian and foreign students at Austrian universities, 1994/95-1998/99

Year group	Mathe-matics	Chemistry	Physics	Biology and Environ-mental Studies	German	History, Social Studies, Political Education	Philosophy, Psychology, Pedagogy
1994/95	65	16	22	37	91	105	48
1995/96	65	5	16	51	84	95	39
1996/97	83	17	25	47	87	128	31
1997/98	89	17	34	63	120	137	41
1998/99	75	15	27	74	119	133	29
Total	**377**	**70**	**124**	**272**	**501**	**598**	**188**

Source: Statistics Austria, University Statistics; ISIS database query

International comparison with negative findings for Austria – lacking comparability of qualifications (university, FHs and CEs)

At the end of this report it is important to examine the international comparison of technology-relevant human resources, because misunderstandings in this respect have been frequent. International educational comparisons include drastically negative findings for Austria. In a recent publication, the OECD e.g. only records some 870 graduates in scientifically oriented subjects per 100,000 employees aged 25-34 in 2003, whereas country means of about 1,500 or 3,000-4,000 for the top nations are published. The reasons for this finding are the traditional dominance of long first-degree HE study programmes and the exclusion of the Ingenieur title awarded by colleges of engineering. Regarding substantial indicators such as the R&D staff rate and the economic output, Austria achieves by far better results than in terms of education indicators.

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