

More and 'Other' Students! How Interdisciplinarity Influences Student Populations in IT Study Programmes in Austria

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Introduction

The European Commission (2010) has extended its Lisbon Strategy into a 'European strategy for smart, sustainable and inclusive growth' for Europe 2020 and pursues, among other objectives, the idea of an 'Innovation Union' (ibid., 10). In this context Europe will need 'to ensure a sufficient supply of science, maths and engineering graduates' (ibid., 11). But although engineering and technology companies offer good job prospects, the number of engineering and technology students is declining in many European countries. In Austria, Denmark, Italy, Germany, Hungary, and Finland, for example, the share of university graduates with science and engineering degrees was in decline between 1998 and 2004 (BMBWK 2003; 2005; OECD 2007).

Although European students agree that science and technology are important areas for European society (European Commission 2001), only a minority of them plans a career in science, engineering or technology (Becker 2009; Dahmen & Thaler 2009; Rommes et al. 2007). The European Union has thus warned about a future lack of SET students and professionals (European Commission 2004). The lack of female students is no longer the only problem engineering education is facing, in fact the proportion of women in science and engineering has risen:

Indeed, She Figures 2009 tells us that the proportion of female researchers is actually growing faster than that of men (over the period 2002–2006, +6.3 % for women and +3.7 % for men). Also, the share of women among scientists and

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engineers has grown by 6.2 %, compared to 3.7 % for men over the same period. (Janez Potocnik, Commissioner for Science and Research, quoted from European Commission 2009, 5)

This means the issue of attracting more students to science and engineering study programmes is no longer exclusively a gender issue. The Royal Academy of Engineering recognised that already in 2000 and announced:

The profession and activity of engineering should set out to be made attractive to the widest possible range of people. Not only is there a very wide range of professionally recognised engineering to offer, from medical engineering to racing car engineering, telecommunications, computer hardware and software, but also a wide variety of activities such as research, conceptual engineering, design, project management, manufacturing, building, operating, maintaining. There are also several levels of qualification all offering rewarding, fulfilling careers; the highly qualified postgraduate engineer, chartered, incorporated or technician engineer. (ibid., 19)

This 'widest possible range of people' is a strong call for diversity in engineering. And indeed, many engineering and technology companies also argue that diverse teams are vital for developing innovative and user-friendly products.

But, a look at the gender distribution of engineering and technology students (number of ISCED 6 graduates by narrow field of study and sex in natural science and engineering 2006; European Commission 2009, 111) reveals that diversity and gender balance in Europe need further efforts. Engineering and computing study programmes in particular still have many more male than female students in Europe. For instance the proportion of female computing students in Austria is 14.8 % (ibid.).

The curricula of engineering study programmes, however, are seen as major factors in whether young people opt for studying engineering or not. A German-Austrian comparative analysis of engineering study programmes has shown that interdisciplinary engineering programmes (combining engineering with economics, management or ecological subjects) have more female students than relatively mono-disciplinary engineering programmes (Thaler 2006; 2008). This analysis of 22 engineering study programmes

revealed that in the same field of engineering education some have more female students than males. The study also showed how educational frameworks influence the share of female engineering students by comparing the degree courses in terms of descriptive elements such as curricula, media elements such as websites, and interviews with persons responsible for the study programmes. It could be proved that the study programmes' focus in content, didactic details and also the proportion of compulsory courses influence the share of female students, which varied from 3 to 100 % and that interdisciplinary study programmes in particular had, on average, more female students (Thaler 2008). Furthermore German mono-educative (women's only) study programmes are designed to be interdisciplinary and are very successful in attracting female students (ibid.).

Christine Wächter recommends integrating at least 25 % social and economics subjects to raise the share of female students, based on findings of the European INDECS study (Wächter 2004; 2005; see also: Beraud 2003). In WomEng, another EU project (for further information see: Dahmen 2006; Thaler & Wächter 2005), a survey among 699 female and male European engineering students and 637 students of different non-engineering majors (social sciences, humanities, economics, etc.; as a control group) showed that more than one third of the engineering students want to have more non-engineering subjects in their curricula. Besides this, more than a quarter of the non-engineering students also say that they would have chosen an engineering study programme if more subjects from human and social sciences had been included (Thaler & Wächter 2005). These results are confirmed by the findings of the above comparative analysis of 22 study programmes in Austria and Germany with different shares of female students: degree courses with more female students differ from those with predominantly male students mainly in their degree of interdisciplinarity and in their participation of female lecturers (Thaler 2006). The conclusion of both studies (Thaler & Wächter 2005; Thaler 2006) is a recommendation for curricular reforms in engineering, as the lower share of women is an expression of structural problems. It points to an inconsistency between curricula and actual requirements of job realities (Freitag 2010). Narrowly designed ('mono-disciplinary') engineering curricula can pro-

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duce engineering graduates who lack certain social and intercultural competencies, which are also required in the profession (ibid.). In other words, interdisciplinary engineering education is appreciated by companies as well.

But can the findings gained from qualitative research in recent years be substantiated by current empirical quantitative research? And are the results from engineering study programmes equally true for the special field of information technology? In this chapter current data of Austrian information technology (IT) study programmes gathered within the EU project HELENA¹ are presented.

Methodology

Sample

In a first step the whole population of 56 IT study programmes at Austrian universities² was analysed quantitatively. The sample (see Table 1) was gathered from the website of the Austrian Federal Ministry of Science and Research.³

In a second step the authors chose four comparable case studies based on the degree of interdisciplinarity of the curricula, female share among enrolled students and representativeness (more than 100 students enrolled) in order to analyse the following study programmes qualitatively and in detail:

- Information Management at Klagenfurt University
- Media IT at Vienna University of Technology
- Business IT at University of Linz
- Software Development and Business Management at Graz University of Technology

Table 1. Analysed IT study programmes at Austrian universities

University	Degree		Total study programmes
	Bachelor	Master	
University of Vienna	1	4	5
University of Graz	1	1	2
University of Innsbruck	1	2	3
Vienna Medical University	0	1	1
University of Salzburg	1	2	3
Vienna University of Technology	6	12	18
Graz University of Technology	3	4	7
Vienna University of Economics and Business Administration	0	1	1
University of Linz	3	7	10
Klagenfurt University	3	3	6
Total	19	37	56

Source: Table from Jenny Käfer, with data from Austrian Federal Ministry of Science and Research 2010a and university websites (cf. References)

Quantitative analysis

In order to answer the research question of how interdisciplinarity could have a positive impact on a more gender balanced student population for Austrian engineering study programmes, two concrete hypotheses were established:

- (1) Interdisciplinary IT study programmes with more than 25 % non-engineering subjects have more female students than relatively 'mono-disciplinary' IT study programmes with less than 25 % non-engineering subjects.

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- (2) Interdisciplinary IT study programmes with more than 25 % non-engineering subjects have more female graduates than relatively 'mono-disciplinary' IT study programmes with less than 25 % non-engineering subjects.

The ratio of 25 % non-engineering subjects for the definition of interdisciplinary study programmes was chosen on the basis of previous studies and recommendations (Wächter 2005).

To answer the two hypotheses all engineering vs. non-engineering subjects of each study programme were counted and compared on an ECTS basis (for a comprehensive description of the HELENA methodology see: Godfroy et al. 2010). To decide whether the subject is engineering or non-engineering the course title and course material and descriptions were analysed as well. Fully optional subjects (electives) were not included in the analysis. Finally, the data were entered into a database set up for the HELENA project, and enabled retrieval of various output possibilities.

Qualitative case study analysis

The quantitative analysis was complemented by a second, more profound case study analysis. All interdisciplinary subjects were listed and all existing PR material (like websites, brochures, folders, and flyers) were analysed to answer the following questions:

- Does the title of the study programme represent interdisciplinarity? (e.g. IT vs. health care IT)
- How do they describe their students' target groups – who are they aiming at?
- How do they describe the job profile of graduates?
- Do they mention certain interdisciplinary key words like society, social, environment, environmental, user, people, human, sustainable, etc.?
- What do they say about didactics, methods of teaching and learning?
- Do they include project work, internships, stays abroad etc.?

Results

Quantitative data and curriculum analysis

The curriculum analysis shows that seven programmes have at least 25 % non-engineering subjects and 49 study programmes have less than 25 % non-engineering subjects and are relatively mono-disciplinary. The next table shows the output of the database for answering hypothesis 1: 'Inter-disciplinary IT study programmes with more than 25 % non-engineering subjects have more female students than the relatively 'mono-disciplinary' IT study programmes with less than 25 % non-engineering subjects.'

Table 2. Database output for testing hypothesis 1

	All study programmes	Study programmes with at least 25 % interdisciplinary ECTS	Study programmes with less than 25 % interdisciplinary ECTS
mean (value) of all female 1st year students (%)	18.82 %	31.02 %	17.77 %
mean (value) of all female students enrolled (%)	15.23 %	25.98 %	14.60 %

Source: Table from Jenny Käfer, with data from HELENA Database

The output shows that the share of female first year students in IT study programmes with at least 25 % interdisciplinarity (in ECTS) is about 13.25 %points higher than in study programmes with less than 25 % interdisciplinarity. And the proportion of female students enrolled in IT study programmes with at least 25 % interdisciplinarity is about 11.38 % points higher than in study programmes with less than 25 % interdisciplinarity.

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The results show that interdisciplinary study programmes with more than 25 % non-engineering subjects have more female students than relatively mono-disciplinary engineering study programmes. Therefore hypothesis 1 is true for IT study programmes in Austria.

The next table shows the output of the database for answering hypothesis 2: 'Interdisciplinary IT study programmes with more than 25 % non-engineering subjects have more female graduates than relatively 'mono-disciplinary' IT study programmes with less than 25 % non-engineering subjects.'

Table 3. Database output for testing hypothesis 2

	All study programmes	Study programmes with at least 25 % interdisciplinary ECTS	Study programmes with less than 25 % interdisciplinary ECTS
mean (value) of all female graduates (%)	15.28 %	21.54 %	14.99 %

Source: Table from Jenny Käfer, with data from HELENA Database

The output shows that the share of female graduates in IT study programmes with at least 25 % interdisciplinarity (in ECTS) is about 6.55 % points higher than in IT study programmes with less than 25 % interdisciplinarity. But only four of our seven interdisciplinary study programmes were considered in this calculation. The three other programmes have a high proportion of female students, but have no graduates yet.⁵ This percentage was thus calculated from only four study programmes and this factor should be considered for a representative result.

There is a tendency in Austria for women who study interdisciplinary IT programmes to have a higher success rate than women in relatively mono-disciplinary IT study programmes. More statistical data is needed to test the significance of this result.

Qualitative analysis of four case studies

The following qualitative case study analysis is based on a sample chosen by representativeness (number of students), degree of interdisciplinarity and share of female students.

Table 4. Austrian case studies

Case Study 1 'interdisciplinary'	Case Study 2 'traditional'	Case Study 3 'interdisciplinary'	Case Study 4 'traditional'
Information Management, Klagenfurt University	Media Information Technology, Vienna University of Technology	Business Information Technology, University of Linz	Software Development and Business Management, Graz University of Technology

Case Study 1:

Information Management at Klagenfurt University

Klagenfurt University was established in 1970 as the 'College of Educational Sciences in Klagenfurt' (Klagenfurt University website⁶). In the winter term 2008 the university had 7,146 regular students: 4,615 female and 2,531 male, resulting in a proportion of women of about 65 % (BMBWK 2009, 31).

Information Management was established in 2005 at Klagenfurt University and confers the degree 'Bachelor of Social Sciences and Economics'. The study programme is highly attractive to female students: the proportion of female first year students (40.4 %), enrolled students

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(32.0 %) and graduates (33.3 %) is relatively high (Klagenfurt University website⁶) compared to the average share of female students in Austria's IT study programmes (18.8 % first year students, 15.2 % enrolled students, 15.3 % graduates, see Tables 2 and 3). Information Management has about 43 % interdisciplinary ECTS and therefore the highest proportion of non-engineering subjects of all the study programmes analysed.

Information Management is an IT study programme with a main focus on business economics and management. The university website defines information management as *'the management of business information using modern information and communication systems. Business and society are increasingly dominated by the use of digital information and communication media. Business for this reason has an increasing need for specialists in the field of these technologies. (...) Importance is attached to the linking of business administration subject knowledge with IT know-how'* (Klagenfurt University website⁷). Law, English and Gender studies courses are included as compulsory subjects or as compulsory optional subjects.

The Information Management study programme at Klagenfurt University is an interdisciplinary programme and is also presented as such. The proportion of female students is relatively high: 40 % first year students, 32 % enrolled students and 33 % graduates. Business economics is the second focus in the IT study programme, and the curriculum is complemented by subjects such as law and courses in English and Gender Studies. Job perspectives for graduates are manifold and not limited to IT and engineering.

Case Study 2:

Media IT at Vienna University of Technology

The Vienna University of Technology was founded in 1815 as an Imperial and Royal Polytechnical Institute (German: *k.k. Polytechnisches Institut*). In 1872 its name was changed to College of Technology (*Technische Hochschule*) and in 1902 the first doctorates were awarded (Vienna University of Technology website⁸). It is the largest university in Austria in the field

of engineering and natural sciences (ibid.). In the winter term 2008 the university had 19,348 regular students: 4,791 female and 14,557 male; the proportion of women is about 25 % (BMWK 2009, 31).

Media IT was established at the Vienna University of Technology in 2001 and the study programme confers the degree 'Bachelor of Science'. The proportion of female students (26.1 % first year, 23.8 % enrolled and 29.4 % graduates; ibid.) lies above the Austrian average (see Tables 2 and 3). The study programme is relatively mono-disciplinary, as it has only about 11 % non-engineering subjects.

Media IT is relatively engineering-focussed – comprising design, computer graphics, image processing and multimedia – with only a few non-engineering subjects, for example in sociology and communication (ibid.). At the Vienna University of Technology five different bachelor courses in IT are combined in a common first year course (ibid.).

Media IT has only about 11 % non-engineering subjects, the proportion of female students is: 26 % first year students, 24 % enrolled students, 29 % graduates. The higher share of female students compared to other relatively mono-disciplinary IT study programmes could be explained by its specialisation in Design which offers many non-engineering subjects.

Case Study 3: Business IT at University of Linz

The University of Linz was founded in 1966 as an Academy for Social and Economic Sciences and is one of the youngest universities in Austria. The Faculty of Technical and Natural Sciences was introduced in 1969 (University of Linz website⁹). In the winter term 2008 the university had 12,374 regular students: 5,779 female and 6,595 male, resulting in a proportion of women of about 47 % (BMWK 2009, 31).

Business IT is a very new study programme and was established at the University of Linz in 2008. Graduates are awarded the degree 'Bachelor of Science' (University of Linz website⁹). The proportion of

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female students is about 6 % above the Austrian average (see Tables 2 and 3): 24.1 % first year students and 21.4 % enrolled students.¹⁰

Data for graduates are not available because the study programme was only established in the winter term 2008 and the first students are thus due to graduate in 2011. Business IT has about 35 % interdisciplinary ECTS, making it the study programme with the second highest degree of interdisciplinarity in the case study sample.

This study programme includes many courses (and ECTS) in business economics and management. Gender Studies and language courses in English are also included as compulsory subjects. Business IT includes areas of technology and engineering as well as business administration and social sciences. The website describes the study programme as an interdisciplinary programme which has been '*designed to not only educate students in fields of information and communication systems applied in industry, business management and administration, but also provide students with a background in theoretical principles and practical application*' (University of Linz website¹¹).

The Business IT programme is presented as an interdisciplinary engineering course. Actually, the study programme is not 'simply interdisciplinary' by combining engineering with some business courses like others, but also includes language courses and Gender Studies as compulsory subjects. The proportion of female students is higher than in the comparable, relatively mono-disciplinary case study 4.

Case Study 4: Software Development and Business Management at Graz University of Technology

The University of Technology in Graz was founded in 1811. In 1864 the status of the 'school' was raised to that of a technical college (Graz University of Technology website¹²). In the winter term 2008 the university had 10,253 regular students: 2,167 female and 8,086 male. The proportion of female students is 21 %, which is the lowest share of all four universities (BMWK 2009, 31) analysed.

The study programme Software Development and Business Management was established in 2005 and students graduate as 'Bachelor of Science'. The share of female students corresponds approximately to the Austrian average in IT study programmes (Tables 2 and 3): 21.5 % first year students (compared to 18.8 %), 13.1% enrolled students (compared to 15.2 %) and 18.5 % graduates (compared to 15.3 %; Graz University of Technology website¹³).

Software Development and Business Management has about 19 % interdisciplinarity, comprising non-engineering subjects in business economics, management, law and sociology. The study programme is presented on the internet as a combination of technology and economic sciences and promises that *'students acquire the basic principles of mathematics, computer science including perspectives derived from mathematics, software development including an orientation towards computer programming, knowledge management including the examination of data, the basic principles of economics – from cost accounting up to industrial management – and the promotion of personality development'* (Graz University of Technology website¹⁴).

The study programme Software Development and Business Management offers only 19 % non-engineering subjects and is thus below the study's limit of 25 % specified for interdisciplinary study programmes. However, the study programme is presented as an interdisciplinary course on the internet. It is an IT study programme with some courses in business management and thus different from Business IT in Linz, which is an interdisciplinary study programme with a second focus on business management in addition to information technology.

Discussion of results

The four Austrian case studies can be compared in pairs, by choosing two with similar topics. One pair is case studies 1 and 2: Information Management (Klagenfurt) vs. Media IT (Vienna), the other one is case studies 3 and 4: Business IT (Linz) vs. Software Development and Business Management (Graz).

A comparison of the first two case studies revealed that Information Management (Klagenfurt) has about 31 % more interdisciplinary subjects, and the proportion of female first year students is 14 % higher than in the relatively mono-disciplinary case of Media IT (Vienna). The proportion of female enrolled students is about 8 % higher and the share of female graduates about 4 % higher than for the Media IT programme (see Table 5).

The analysis for the second two case studies showed that Business IT (Linz) has about 16 % more interdisciplinary subjects and about 8 % more female students than the relatively mono-disciplinary study programme Software Development and Business Management (Graz) (see Table 5).

Generally, all four case studies offer a certain extent of non-engineering subjects (from 11 to 43 %). But only two study programmes clearly exceed the limit of 25 % non-engineering subjects as a measure for interdisciplinarity, while the other two are below that limit. One of them, the Media IT programme in Vienna (11 % interdisciplinarity) represents a typical IT study programme in Austria, predominantly engineering subjects mixed with around one tenth non-engineering subjects. All four case studies, to some extent, carry interdisciplinarity in their titles.

The proportion of female students in the first year ranges from 21.5 to 40.4 % in all four case studies and thus above the Austrian average in IT study programmes. Only the number of enrolled female students in the relatively 'mono-disciplinary' case of Software Development and Business Management (13.1 %) is below the corresponding average value for Austria.

The main similarity that can be recognised across all the case studies is a certain degree of practical orientation, which is mentioned in all study programmes. Practical orientation seems to be a key factor in presenting IT study programmes at the universities analysed, but no study programme actually includes internships as is the case with universities of applied sciences. An international focus is also emphasised in all the study programmes, but again, no study programme offers the opportunity to study abroad. Only the website of the interdisciplinary Business IT programme in Linz gives a recommendation about spending a semester abroad. The job perspectives of all four cases have similarities as well: all study programmes mention a wide range of career options for their graduates on their websites.

Table 5. Database output for Austrian case studies

	Case Study 1 'interdisciplinary'	Case Study 2 'traditional'	Case Study 3 'interdisciplinary'	Case Study 4 'traditional'	Average % in Austrian IT study programmes
	Information Management, Klagenfurt University	Media Information Technology, Vienna University of Technology	Business Information Technology, University of Linz	Software Development and Business Management, Graz University of Technology	
female 1st year students (%)	40.4	26.1	24.1	21.5	18.8
female enrolled students (%)	32.0	23.8	21.4	13.1	15.2
female graduates (%)	33.3	29.4	–	18.5	15.3
degree of interdisciplinarity (%)	43	11	35	19	11

Source: Table from Anita Thaler, with data from HELENA Database

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Apart from these similarities, the study programmes differ, for example, in regard to gender topics, as in whether or not they include Gender Studies in the curriculum. The folder of the interdisciplinary Business Information Technology programme in Linz emphasises gender equality and a focus on female students. The other interdisciplinary study programme, Information Management (Klagenfurt), includes Gender Studies in the list for compulsory optional subjects. The two relatively ‘mono-disciplinary’ cases mention Gender Studies, if anything, only as fully optional subjects.

Other differences concern the ‘target groups’ of the study programmes. Media IT (Vienna) with the lowest degree of interdisciplinarity seems to focus predominantly on male students, as men are more often presented in information brochures than women. This study programme also uses only one interdisciplinary key word (‘social skills’) in the PR material, while the other cases not only use more interdisciplinary key words, like society, social, environment, environmental, user, people, human, sustainable, but also present female and male students equally in their brochures.

Conclusions and recommendations

Can interdisciplinarity enhance diversity in the engineering student population? Can interdisciplinary engineering study programmes attract students who would not otherwise study engineering? And can interdisciplinarity bring in not only more topics but also more students to engineering?

Previous research has given some indication that interdisciplinarity could indeed bring in more women students (Thaler 2006; 2008; Wächter 2004; 2005) and that there is a great potential of young people who would study engineering if the study programmes included more non-engineering subjects (Thaler & Wächter 2005; 2006). Additionally, companies would appreciate interdisciplinary engineering education (Freitag 2010): ‘The interviewed company representatives and employers point out the importance of on the one hand solid theoretical education but on

the other hand the education of young engineers in social and management skills, when they speak about their preferred alumni. This mainly refers to the inclusion of more courses in presentation and communication technologies, economics / law and languages' (ibid., 9).

The previous studies, however, either used qualitative research (like interviews) or surveys on a scale too small to have an impact on engineering education policy. One aim of the EU project HELENA was to collect a representative amount of data in order to present not only qualitatively meaningful but also quantitatively significant results. In this chapter, the authors presented Austrian data for information technology. For the first time ever, all IT study programmes at Austrian universities were researched; degrees of interdisciplinarity were calculated and the proportion of female students has been brought into relation at different levels (first year, enrolled, graduates).

The statistical procedures clearly showed that IT study programmes with a higher degree of interdisciplinarity have more female students.

Furthermore, the qualitative case study analysis demonstrated that interdisciplinary IT study programmes which present their interdisciplinary focus and promote gender equality in their PR material attract more female students.

Based on those results a definite recommendation can be made for IT study programmes in Austria to include more non-engineering subjects in their curricula, to promote this interdisciplinary focus in order to attract more female students and gain a more diverse student population.

Notes

- ¹ The project 'HELENA – Higher Education Leading to ENgineering And scientific careers' is carried out within the European Union's 7th Framework Programme 'Science in Society' (<http://www.fp7-helena.org/>) under the coordination of Siauliai University (Lithuania). This chapter presents Austrian results of work package 4, led by Christine Wächter.

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- ² This does not include study programmes at Universities of Applied Sciences.
- ³ <http://www.bmwf.gv.at/startseite/hochschulen/universitaeten/gesamtuebersicht/> {16.03.2010}
- ⁴ The degree of interdisciplinarity is calculated by the percentage of all non-engineering subjects in the curricula of the study programmes. Non-engineering subjects are all subjects except engineering, technology, physics and mathematics subjects. Examples for non-engineering subjects are management, business, economics, languages, cultural studies, sociology, politics, psychology, philosophy, ethics arts, STS – science, technology and society, communications, law, history, design, gender studies, inter-cultural competencies, diversity management, and ‘soft skills’.
- ⁵ Some of the study programmes are new and they started for example in the winter term of 2008 or 2009 and have no graduates yet. The numbers for graduates are available at the earliest 2010 or 2011.
- ⁶ <http://www.uni-klu.ac.at/english/> {30.08.2010}
- ⁷ http://www.uni-klu.ac.at/english/inhalt/540_985.htm {30.08.2010}
- ⁸ <http://www.tuwien.ac.at/> {30.08.2010}
- ⁹ <http://www.jku.at> {30.08.2010}
- ¹⁰ Information from the Department of Affirmative Action and Policies for Equal Opportunity, University of Linz, e-mail {06.04.2010}.
- ¹¹ <http://www.jku.at/content/e262/e242/e2380/e2268/> {18.03.2010}
- ¹² <http://portal.tugraz.at/> {30.08.2010}
- ¹³ https://online.tugraz.at/tug_online/StudierendenStatistik.html {30.08.2010}
- ¹⁴ <http://portal.tugraz.at/> {30.08.2010}

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